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Prosperity for American Shipbuilders

Never before in this generation has a new year begun with brighter prospects for the shipbuilders in the United States. Over 200 merchant vessels, totaling about 700,000 gross tons, are now under construction in American shipyards, and the number of inquiries out for new tonnage, not only from shipowners in the United States, but also from foreign shipowners, give every indication that the present boom in shipbuilding will last for several years. Most of this tonnage is in the form of large seagoing vessels, suitable for foreign trade and eminently fitted for service as naval auxiliaries. About one-half of the tonnage of large seagoing vessels consists of oil tankers. The majority of the remainder consists of colliers or general freight-carrying steamships, although six large passenger and freight steamships are also under construction. On account of the havoc wrought by the European war on the shipping and shipbuilding industries of the belligerent nations, not only has the scarcity of tonnage caused an unprecedented demand for American-built ships, but the resulting market conditions have made the prices for new tonnage wholly favorable to American shipbuilders.

Government vs. Private Ownership

One of the main reasons put forth by the Administration at Washington for presenting to Congress a bill for Government ownership of vessels has been that private capital would not invest in ships for service in the foreign trade. This argument may have had slight force when it was first presented, but it has been a great mistake on the part of the Administration and its friends to continue arguing along these lines.

We have records in our office of over 90 seagoing steamships under contract in shipyards on the Atlantic coast, representing an investment of more than $75,000,000 (£15,350,000). These figures do not include a large number of contracts for smaller craft that could not be classified as seagoing vessels, which represent many millions of dollars, nor do they include contracts for a considerable number of seagoing vessels that have been placed in shipyards on the Pacific coast. Eight or ten large vessels are under construction on the Great Lakes, but naturally they are for service only on the lakes. Also the several Welland Canal-size vessels under construction on the Great Lakes are for coastwise service only.

Outside of the smaller vessels under construction on the seacoasts and on the lakes, it is safe to say that nearly $100,000,000 (£20,500,000) is represented by contracts already placed for seagoing vessels in this country, and that the number is well over 100. The proposition of the Administration, therefore, to have the Government spend $50,000,000 (£10,250,000) in purchasing ships for service in the foreign trade will accomplish only a small part of what is already being done by private capital, especially as there would be other expenses besides the mere purchasing of ships.

Geared Turbines

An interesting discussion of the subject of geared turbines and turbo-electric systems of propulsion is contributed to this issue by Mr. John H. Macalpine, who with the late Rear Admiral George W. Melville, former engineer in chief of the United States Navy, invented the floating frame reduction gear now manufactured by the Westinghouse Machine Company. This discussion is called forth by the recent successful trials of the United States collier *Neptune*, on which the first Westinghouse geared turbine machinery was installed.

The *Neptune* exceeded her contract speed of 14 knots by more than a quarter of a knot and her coal consumption was fully 15 percent within her guaranteed consumption. Recent developments of the Westinghouse geared turbine machinery, however, lead to the belief that far greater economies will be obtained with this form of propulsion, not only at full power, but also at reduced speeds. Geared turbine installations are now being built for two foreign warships of 22,000 horsepower each in which a water rate of the turbines at full power of 10.8 pounds per shaft horsepower per hour is guaranteed and a rate of 10.5 pounds at from 80 to 85 percent of full power. At quarter load the guaranteed water rate is only 11.5 pounds, or 6.5 percent, above the full power rate.

This result is to be accomplished by the use of what the Westinghouse Company has called a divided flow turbine applied to reduction gears. In this system, as explained in Mr. Macalpine's paper, the high-pressure turbine is of the impulse reaction type in which an astern

turbine of 60 percent of the full ahead power is incorporated. The low-pressure turbine is of the Westinghouse reaction double flow type. Both the high- and low-pressure turbines are geared to the same shaft. All of the steam is admitted through groups of nozzles to the high-pressure impulse wheel, after which at full load one-third of the steam is expanded through the reaction blading of the high-pressure element, while the remaining two-thirds passes to the low-pressure turbine. At cruising speed the low-pressure turbine is shut off entirely and the small high-pressure turbine of only one-third the capacity of the entire unit is in operation at its full rating.

The possibilities of such geared turbine arrangements on single or multiple shaft installations with a view to economical operation at various speeds and savings in weight and space are obvious. That the geared turbine is far beyond the experimental stage and is steadily gaining favor among shipowners and marine engineers is evidenced by the fact that several thousand horsepower are built or building, not only for naval work, but also for merchant vessels.

Fireproof Excursion Steamers

Ever since the burning of the *General Slocum* the Supervising Inspector-General of the United States Steamboat Service has repeatedly urged that excursion steamers be constructed of fireproof materials. This recommendation is again made in the annual report of the Secretary of Commerce, who asks for the enactment of legislation "to provide that on and after January 1, 1918, excursion steamers carrying 250 passengers or more shall be constructed of strictly fireproof materials."

The question of fireproof construction of vessels has been discussed at length a number of times in recent years at meetings of the Society of Naval Architects and Marine Engineers. In 1906 Mr. William Gatewood, naval architect of the Newport News Shipbuilding & Dry Dock Company, described an adaptation of fireproof construction to the building of the *Jamestown,* an excursion steamer 262 feet long, 38 feet molded beam, and 14 feet 6 inches molded depth, for service on the Potomac River. This vessel was built of strictly fireproof materials, and, as compared with a similar vessel of ordinary construction, involved an increase of both weight and cost of about 10 percent. At the same meeting a fireproof ferryboat of 625 tons displacement, built for use between Philadelphia, Pa., and Camden, N. J., was described by Mr. F. L. DuBosque. In this vessel the increased cost was about 7 percent and the increased weight about 5 percent. At a later meeting of the Society in 1912 a proposed design of an electrically propelled fireproof excursion steamer was described by Mr. William T. Donnelly, and, although the weight and cost of the vessel were materially increased over those for an ordinary excursion steamer, nevertheless it was estimated that the increased economy of the propulsive machinery and the use of the power plant for commercial purposes in the winter months would more than offset the increased cost.

The discussion of these papers centered mainly on the use of all-steel construction for fireproof vessels, and the opinions expressed may be summed up in the statement that except in special cases the use of steel for the construction of a strictly fireproof vessel is likely to be impracticable, if not impossible. In excursion steamers for day service only, with open decks and a minimum amount of divisional bulkheads (largely of glass) on the upper decks, the use of steel or other strictly fireproof materials is undoubtedly feasible. The weight and cost will be greater, but not prohibitive. The problem is similar to that involved in the case of the *Jamestown* or the ferryboat referred to above. In the case of vessels with large superstructures above the main deck, however, such as the night boats on the Hudson River or Long Island Sound, the difficulties of fireproof construction encountered, such as the discomfort to passengers and crew from heat in the summer in structures entirely of steel, the objectionable springiness of light steel decks and the additional weight and cost of steel upper works are very likely to be found prohibitive. When the *Plymouth,* of the Fall River Line, was burned in March, 1916, the question of rebuilding the vessel entirely of steel was carefully investigated, but the increased weight was found prohibitive for this class of vessel. As a solution of the problem various means of retarding and preventing fires were adopted, such as partial steel construction, fire bulkheads and a complete automatic-sprinkler system; but, above all else, chief reliance was placed on a highly disciplined fire patrol or watch by the officers and crew of the vessel, which has proved extremely effective on this, as well as other, first-class steamship lines.

In view of the experience brought out in the discussion of this subject, the use of strictly fireproof materials in vessel construction should not be made compulsory until the type and service of the vessel for which such construction is intended are clearly defined, as well as the classes of materials that will be accepted as "strictly fireproof." Other fireproof materials, lighter than steel, must enter largely into such construction if the term "excursion steamer" is to apply to all vessels used for excursion purposes.

Japanese Shipbuilding and Shipping

Reports from Japan show that in the various Japanese shipyards sixty-five seagoing steamships of about 290,000 tons are now under construction for Japanese and foreign firms. In 1915 eight vessels of about 53,000 tons have been built, while most of the others now under construction will probably be completed in 1916.

This activity in the Japanese shipyards is the direct result of the policy of the Japanese Government in fostering its shipping. Aside from the regular subsidized Japanese steamship lines running to America, Australia, China and Russia, the greatest activity of Japanese shipping interests

is to be found in the increasing use of tramp steamers in foreign trade. The tramp steamers belonging to the Japan Ship Owners' Union number about 240, exclusive of vessels whose tonnage does not exceed 500 tons, and most of them are owned by individuals. Of this number, 41 vessels are chartered by the large subsidized steamship companies; twenty are engaged in regular ocean voyages under the management of individual shipping firms; sixty-seven are engaged in coastwise service, and fourteen large steamers are chartered by foreign firms. About eighty-two large steamers, whose tonnage is over 3,000 tons, are engaged in over-seas trade; ten on the Australian line; ten on the American line; twenty-three on the South Seas, Indian and Australian lines; eighteen on the Manchuria and Vladivostok line, and twenty-one on the Chinese coast line. In addition, about fifty-five large vessels are chartered out to firms engaged in foreign trade.

Needless to say, this remarkable progress in Japanese shipping and shipbuilding is bringing Japan into an enviable position in the control of trade on the Pacific Ocean.

New Cutters Needed for the Coast Guard Service

In view of the splendid service which has been rendered by the Coast Guard Service in saving lives and floating property and removing menaces to navigation from the seas, no mistaken policy of false economy should deter Congress from meeting the urgent needs of this service in the matter of appropriations for supplying such vessels as are needed to maintain the service efficiently.

As a matter of fact, several additions to the Coast Guard fleet are badly needed at the present time. The cutters *Perry* and *Tahoma* have been sunk on Alaskan reefs and two new cruising cutters are needed to replace these vessels. In New York harbor there is a tug-boat that is forty-two years old, and in San Francisco harbor there is another boat that is forty years old which is in a wornout condition. These should be replaced by modern, up-to-date craft, and for this purpose three harbor cutters are asked for. In addition, three light-draft river cutters are needed for use on inland waters.

Considering the fact that in the last ten years the construction or purchase of only eleven cutters has been authorized by Congress, and also that of the present fleet ten vessels are more than twenty years old, and three of these more than thirty-five years old, there can be little excuse for failing to meet the requirements of this most important service.

Auxiliary Sailing Vessels

Questions regarding the economy of auxiliary sailing vessels can be answered satisfactorily only by data from the actual service of such vessels. A three-masted fore-and-aft schooner with a loading capacity of 370 tons, fitted with a 120-horsepower reversible crude-oil engine, has been running for more than a year. The economical speed of this vessel has been determined as 8 knots. With a favorable wind the vessel is run under sail power alone, otherwise the auxiliary engine is run with the power necessary to maintain a speed of 8 knots. In a period of 100 days the auxiliary engine on this vessel worked 700 hours with a gross fuel consumption of 17 tons of oil, which figures out as .404 pound of oil per horsepower-hour. Although a higher speed might be obtained by supplying additional power to a boat of this type, nevertheless experience has shown that when the speed was increased above 8 knots the power required was out of proportion to the increase of speed and the resulting benefits. As compared with a sailing vessel, the cost of operation of an auxiliary sailing vessel is, roughly, 40 percent higher. The increased earnings of the auxiliary sailing vessel, however, due to the greater number of voyages possible and the less time required in port for loading and unloading, is something like 140 percent, so that the net surplus in favor of the auxiliary sailing vessel is well worth while when continual employment is found for the vessel.

Cost of Battleship Construction

If it were possible to compare the bids of private shipbuilders for the latest United States battleships with the estimates prepared by navy yards, item for item, it would be found that the figures of the private shipbuilders were in a reality lower than those of the navy yards. Such a comparison, however, as we have pointed out before, is difficult to make, for, while both sets of figures represent the cost to the United States of the same ships, they do not cover the same incidental expenses. In other words, items which private shipbuilders must pay for as a part of the cost of construction are not included in the estimates of the cost of construction by the navy yards:

A few of these items are as follows:

The cost of drawings and plans, which in the navy yards come under a special appropriation.

Salaries of clerks, timekeepers and other minor officials, which in navy yards come out of a general expense account.

Insurance and indemnity bonds, not carried on work in navy yards.

Trial trips of the vessel, not included in the navy yards' estimates, as the trials of Government-built vessels are carried out after the vessels are in service.

If all of these items were summed up, the total would be not far from a million dollars, in addition to which the question of a reasonable profit to the private shipbuilder must be considered.

With these facts in mind, some allowance should be made in competitive bidding for the handicaps under which the private yards are laboring as against the Government-built ships. In the end it is likely to be found that in reality the vessel built in a private yard will cost the nation less than the Government-built ship, to say nothing of the quicker delivery and the additional expense involved in preparing the navy yards for building these ships.

The Geared Turbine and the Turbo-Electric Systems of Marine Propulsion

Successful Trials of Collier Neptune Fitted With Geared Turbines Compared With Performance of Sister Ship With Turbo-Electric Machinery

BY JOHN H. MACALPINE

This short discussion is called forth by the successful trials of the United States collier *Neptune* fitted with geared turbines by the Westinghouse Machine Company. She standardized on November 17 and commenced her full power 12 hours' trial on the same day. The machinery is reported to have acted admirably. The average results of the latter trial were:

Speed.....14.28 knots
Shaft horsepower .....7,175 total
Revolutions per minute of propellers.....115.34
Revolutions per minute of pinions.....2,003
Power constant (explained below).....5.22
Coal.....1.528 pounds per shaft horsepower hour
Water, turbines only, 13.4 pounds per shaft horsepower hr.
Water, all purposes..15.8 pounds per shaft horsepower hr.

The contract speed is 14 knots and the guaranteed coal consumption 1.8 pounds per shaft horsepower hour.

In a long article on "Reduction Gears," discussing fully both theory and practice, which will begin to appear in *Engineering*, London, during January, I deduce what I have called the "Power Constant" by which the performance of gears should be compared. It is

$$C = \frac{1{,}000\,P}{D^2 R}$$

where C = power constant.
P = horsepower transmitted by the gear.
D = diameter of pinion in inches.
R = revolutions per minute of pinion.

The factor 1,000 is introduced to make C fall, usually, between unity and 10.

It can readily be shown that in similar gears, loaded at corresponding points to the same intensity of stress, the value of C is constant; also, applying similar gears to a turbine of a given power and speed, the weight per horsepower is inversely proportional to the value of C. Hence the higher the value of C which can safely be carried the better the design or type of the gear and the more advantageous for adoption on board ship.

The "floating frame" was introduced to raise the safe value of C by producing and automatically maintaining very uniform distribution of pressure between the teeth and thus preventing great local rise of stress through slight errors of alinement of the gear and pinion. With the floating frame, errors of alinement, unless far outside the limits which would ever be allowed to occur in practice, produce no sensible effect. Thus the Westinghouse Machine Company, who have built and are building not far short of 200,000 horsepower of floating frame gears, have gradually raised this constant till $C = 4$ is regarded as a proper value, especially in marine work, and its adoption has met with perfect success. When the late Mr. George Westinghouse reduced the pitch diameter of the *Neptune's* pinions to 7 inches I greatly feared for a successful result as it involved raising C to over 5 and was a great leap beyond all precedent existing at the time. But it is completely successful, in spite of the fact, as I show reason to believe, that the ratio of length of helix to diameter is considerably above the best value. Gears where the bearings are rigid, or "rigid gears," seem always to run at a much lower value of C. This is to be anticipated, for, as calculation shows, an error of alinement of the pinion and gear bearings of 1/1,000 inch, even in a large reduction gear, is serious and will usually give rise to nearly "point contact," and consequently to highly localized stresses in the teeth. Setting the axes so closely as this is a delicate operation, and they will not remain so set. The highest result I know is for the rigid gear of S. S. *Vespasian* where, on the measured mile trial, C reached the value 3 for the mean of the highest runs. But in service her value of C is about 1.85. So far as I can find from published results this is about the high limit of load at which rigid gears are run, and many give much smaller values.

Thus experience confirms theory, showing that the introduction of the floating frame allows of an increase of load with equal safety to over two, and probably to three or more times that of a rigid gear. This I felt sure would be the case long before the first gear was built. In fact, where the effect of slight errors of alinement is so marked, it seems certain that at some time during the life of a rigid gear the length of tooth contact will be reduced at least half, and not improbably to much less than half, its proper amount. At half contact the maximum surface and internal stresses will obviously be approximately quadrupled. That the floating frame performs its function properly is demonstrated by the fact that after long runs, even under heavy loads, the rise of temperature of the pinion is found to be slight.

This high value of C allows, for a given power—

(a) A much smaller and lighter gear for a given ratio of reduction; or

(b) With a given diameter of large gear, of a greater ratio of reduction, reducing the speed of the propeller or increasing the speed and consequently reducing the size and weight of the turbine, and thus increasing the efficiency of the installation.

Though the coal consumption of the *Neptune* is fully 15 percent within the guarantee it cannot be looked on as satisfactory. This is the second set of turbines and gears which have been fitted on the *Neptune*. With the first set the ship failed on her endurance trial because of the inefficiency of the turbines and loss of fresh water thrown overboard by the air pumps. These original gears had acted perfectly but when the turbines were changed it was desired to increase their speed and reduce the speed of the propellers to 110 revolutions per minute, the same as that for the sister-ship *Jupiter* engined with turbo-electric machinery by the General Electric Company. Hence new turbines, gears, and air pumps, were fitted. In the case of the geared turbines for two foreign warships of 22,000 horsepower each, the Westinghouse Machine Company guarantees a water rate at full power of 10.8 pounds per shaft horsepower hour and a minimum rate of 10.5 pounds at from 80 to 85 percent of full load. The curve,

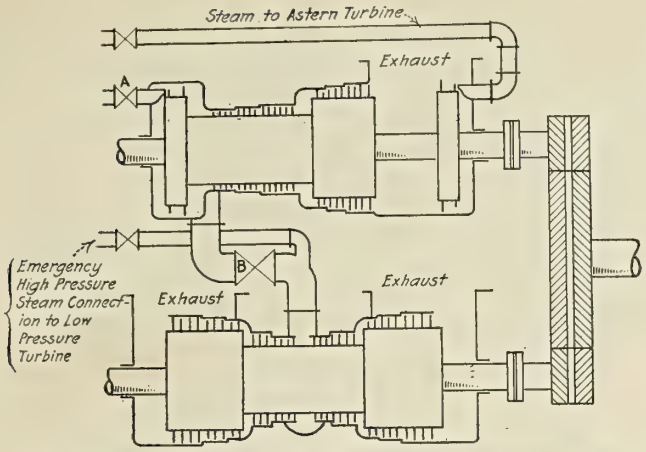

Fig. 1.—Diagrammatic Sketch of Westinghouse Divided Flow Turbine Applied to Reduction Gear

which is shown in the figure, is so flat that at quarter load the water rate is only 11.5 pounds, or 6.5 percent. above full power water rate. This is accomplished with what they call a Divided Flow Turbine for which, however, the method of calculating efficiency contains no new element, and thus the result is not problematical. They believe they have a very safe margin in the guarantee. The *Neptune's* turbine water rate of 13.4 pounds exceeds this full power foreign guarantee by 24 percent.

The Westinghouse Divided Flow Turbine was developed primarily for naval purposes, with a view to obtaining a steam consumption at cruising speed comparable with that usually obtained at full speed. As will be seen from Fig. 1, which is a diagrammatic sketch of a Westinghouse Divided Flow Turbine applied to a reduction gear, the high-pressure element is of the impulse reaction type, while the low-pressure element is of the well-known Westinghouse reaction, double flow type.

The operation is as follows: Steam is admitted to the high-pressure impulse wheel through separate groups of expanding nozzles, each group of nozzles being controlled by a hand-operated valve. At maximum load all nozzles are open. All of the steam admitted to the turbine through valve "A" does work on the impulse wheel, after which one-third of the total steam is expanded through the reaction blading of the high-pressure turbine, exhausting to the condenser. The remaining two-thirds of the steam passes through valve "B" into the low-pressure turbine, where the expansion is completed in the reaction blading, the steam exhausting finally to the condenser at each end of the low-pressure turbine. At cruising speed the cross-connection valve "B" is closed (position "C" on curve, Fig. 2), leaving only the high-pressure turbine in operation, in which case the steam is admitted to the high-pressure impulse wheel through such of the nozzles as are required for the reduced power. After passing the impulse wheel, the steam expands through the high-pressure reaction blading to the condenser.

It will thus be seen that at cruising speed a small turbine of only one-third the capacity of the entire unit is in operation at its full load rating, instead of having in operation a large turbine at fractional rating, as is usual in other marine turbine installations. Shutting off the low-pressure turbine at cruising speed assures a constant pressure of the exhaust from the high-pressure impulse wheel. By this means the energy available, due to expansion in the nozzles, is practically constant at all loads. This is especially desirable when the blade speed is reduced, which is the case at cruising speeds.

A further advantage is found in the fact that the low-pressure turbine operates only at the higher powers, thereby modifying the design of blading, because no attention need be paid to the conditions existing at cruising speeds. The high pressure turbine is bladed with a view to obtaining the highest economy at cruising speed, and, as it is only one-third of the total turbine, sufficient blading can be put in to give high economy at the reduced revolutions at which it operates when cruising. As provision is made for readily disconnecting the low-pressure turbine when on a long cruise, the desired condition is obtained of having fewer units in operation at cruising speeds than at full speed, which is the reverse of that existing on practically all of the turbine driven ships at present in commission.

From the foregoing it is evident that the Divided Flow Turbine has various qualities which make it peculiarly suitable for a gear drive. As two rotors each drive a separate pinion, both pinions meshing with the gear on the propeller shaft, scarcely any accident short of total disablement of both rotors can occur which will not leave the ship free to go forward at nearly full speed with either one or both rotors. The necessary change can be made by manipulating a couple of valves; or, at most, disconnecting a coupling, which might take half an hour. The flexibility and safety thus attained are much greater

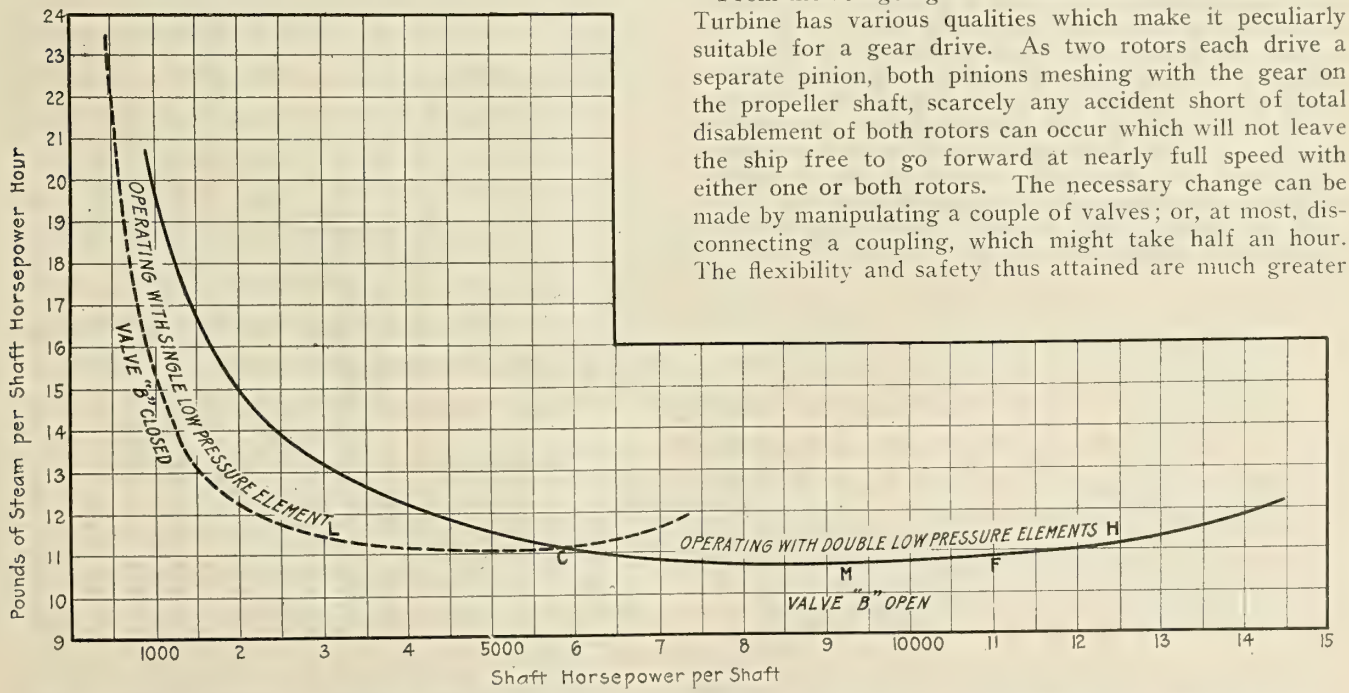

Fig. 2.—Steam Consumption Guarantee, Pounds per Shaft Horsepower Hour for 11,000 S. H. P. Divided Flow Geared Turbine Installation. Dry Steam, 260 Pounds Gage Pressure; 28.27 Inches Vacuum; Revolutions per Minute of Turbines, 3,600 at 11,000 S. H. P.

than those ascribed by Lieut. Robinson to the *Jupiter's* machinery.

The *Jupiter** on her full power trial consumed 1.664 pounds of coal per shaft horsepower for all purposes. This is not a good result. The excess over the performance of the *Neptune* is in part due to inferior firing and uneconomical auxiliaries; but it is also raised by the loss of efficiency in transforming the mechanical energy delivered by the turbine into electric energy and retransforming this into mechanical.

There were also two turbines built for the *Jupiter*. The first, after trial, was rejected and an improved design adopted. On account of the excellence shown by the shop tests the General Electric Company improved all their commercial designs to correspond with this second turbine.† The *Jupiter's* power is measured by a torsion meter on the propeller shafting after the energy has been twice transformed. Her full power water-rate, turbines only, is 11.68 pounds—better than that of the *Neptune's* turbines, but fully 8 percent worse than the full power guarantee for the foreign ships. This we might anticipate. For, with equally well designed machinery, the geared turbine will always show a considerable economy over the turbo-electric drive: the auxiliaries are practically the same; in the geared turbine we have a loss in transmission to the propeller shafting of only from 1 to 2 percent, while the double transformation of the turbo-electric drive at full power must entail a minimum loss of about 10 percent and sometimes a good deal more.

Let us now examine the result at 15 percent of full power, approximately half speed. The curve for the Divided Flow Turbine is still rising slowly and gives 18.5 percent increase over the full power rate. In the turbo-electric drive it is proposed to wind the motors for 30 poles and 50 poles †† so that at 0.6 of full speed of ship the turbines would run full speed. As the winding might readily be for 30 and 60 poles we may suppose the turbines running full speed for half speed of the ship. The *Jupiter's* turbine shows on reduction from 5,000 kilowatts to 750 kilowatts (= say 1,000 horsepower, or 500 horsepower per shaft) a rise in water rate of about 36 percent ‡ If the turbine has to be slowed there is at once an added drop of efficiency and, consequently, a slight rise in the speed of the ship, necessitating reversion to the smaller number of poles, would give a much greater loss than I am about to state. As 1.36/1.185 = 1.15 the Divided Flow Turbine shows 15 percent advantage over the *Jupiter's,* which, it should be noted, cannot be made Divided Flow unless the generators are driven by gears which, we shall see later, would effect a great improvement. At 500 horsepower, the motors of the *Jupiter* have fallen in efficiency to 88.5 percent, and no doubt there is some such drop in generator efficiency also, the curves of which are not given by Lieutenant Robinson. Possibly a motor having two sets of poles would give a somewhat better result, but at best we are left with a loss in the two transformations of from 16 to 20 percent or not much less. At reduced powers the loss in the gears rises very slightly and 4 percent would here be an excessive value, leaving an advantage in favor of the gear against the electric machines of about 12 to 16 percent. As 1.15 × 1.12 = 1.288 the total advantage of the geared turbine is about 25 to 30 percent, under this favorable supposition of full speed of the turbine driving the generator. I make a liberal deduction as the turbine for the *Jupiter* is smaller than that of the foreign ship.

These figures apply particularly to the *Jupiter* with her single turbine and generator. In a ship with two turbines and generators one would be stopped at much reduced power and the above losses considerably reduced but by no means annulled.

Further, even at full power the *Jupiter's* turbine has not reached maximum efficiency, and the slightest reduction from full speed increases the water-rate and that fall accelerates as the power continues to fall. This is very inferior to the foreign guarantee curve. Hence, what I believe were the most prominent claims for the turbo-electric system, increase of efficiency both at full and very low powers, are possessed in a higher degree by the geared Divided Flow Turbine.

There are three requirements of prime importance on shipboard—efficiency, simplicity, and lightness.

With the first I have already dealt. But, as every engineer knows, the maintenance of efficiency is surer the simpler the machine or system.

Lieutenant Robinson's papers are obviously written by a strong believer in the superiority of the turbo-electric drive. But one has only to study them carefully to be impressed by the complexity of the plan. The principal complication is the indirectness of the drive which, as we have seen, lowers efficiency. But besides that there are large air ducts, water-cooled rheostats, a very exact governor, switch and gage boards and control stand which not only have the usual pressure gages, levers, etc., but also an imposing array of electric meters, oil switches, rheostat, short-circuiting levers electrically locked by solenoids, mechanical locking devices, and so on, testifying eloquently to the complexity both of the system and of its operation.

The following are weights of corresponding parts of the main propelling machinery of the three sister ships. They contain the condensers, air and circulating pumps for each; for the *Cyclops* the reciprocating engines; for the *Jupiter* the turbine, generators, motors, switchboard, exciter and gear, cables, etc.; for the *Neptune* the turbines and reduction gears:

Cyclops	342.6 tons
Jupiter	223.0 "
Neptune	188.9 "

The following are carefully estimated weights for a 10,000 horepower twin-screw ship. It includes the main propulsive machinery without boilers, auxiliaries, etc. The estimate was made by the Westinghouse Electric and Machine Companies and on it they submitted bids:

(a) Geared turbines	274,000 pounds
(b) Turbo-electric drive (using geared generators)	304,000 "
(c) Turbo-electric drive (using direct-connected generators)	423,800 "

(b) is 11 percent and (c) 54.7 percent above (a).

The *Jupiter's* engine room extends 20 frame spaces and the *Neptune's* 18, a saving of 2 frame spaces or 5 feet.

It is stated* that "The present claims of the contractors for the machinery of the *Jupiter* are that it is lighter, takes up less space, and is more efficient than any other form of ship propulsion." These claims are far from being supported by the facts.

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* Most of my information regarding the *Jupiter* is derived from the *Journal of the American Society of Naval Engineers.* The references in the sequel are principally to two papers in Vols. XXV. and XXVI., by Lieutenant S. M. Robinson, U. S. N. There is also a paper by Lieutenant Robinson in INTERNATIONAL MARINE ENGINEERING, Vol. XX., page 19, which I have read in abstract in the *Journal of the American Society of Naval Engineers,* Vol. XXVII., page 199, since writing what follows. It does not modify what is said in the two earlier papers.

† See *Journal of the American Society of Naval Engineers,* Vol. XXVI., pages 347, 348.

†† See *Journal of the American Society of Naval Engineers,* Vol. XXVI, page 350.

‡ The curve in Vol. XXVII., page 201, *Journal of the American Society of Naval Engineers,* is carried down to 1,000 kilowatts, and slight extension shows the above result for 750 kilowatts.

* *Journal of the American Society of Naval Engineers,* Vol. XXV., page 550.

Lieutenant Robinson also puts forward the claim of less weight and space, but it is at once disclaimed in a footnote as not holding when the comparison is with geared turbines or the hydraulic transmitter. He also claims, as a valuable asset in a man-of-war, the short time of starting up and similarly disclaims it in a footnote. In all, he formulates a list of eleven claims which it would take far too much space to examine in detail, but no one of which would stand, better than those we have examined, in comparison with the geared turbine. I will only state one†—"(9) The readiness with which repairs can be effected. There is hardly any accident that can be conceived that could not be readily repaired by the ship's force." The burning out of the generator or motor, for instance, by short-circuiting, necessitating partial or complete rewinding? This claim is necessarily untrue of *any* system of propulsion. With the geared turbine, the pinions and turbines become so small that spare pinions and turbine rotors could readily be carried, as well as ample spare turbine blading, and that comes much nearer fulfilling the claim than is the case with the turbo-electric drive. It has sometimes been claimed as a great advantage that the turbo-electric drive can exert full power astern without having an astern turbine. As every marine engineer knows, full power astern will cause the engines to race. The Divided Flow Turbine, by the addition of a single two row impulse element for the astern turbine can develop fully 60 percent of the full ahead power on the same steam flow, which is ample. It adds no sensible complication or loss from friction. Both propellers may be promptly reversed by the operation of a single handwheel. This is even simpler than for a reciprocating engine and much simpler than the multiple operations described by Lieutenant Robinson for reversing the *Jupiter*.*

But the turbo-electric system has disadvantages peculiar to itself:

(1) The operation is unusually complex, as I have indicated, thus requiring higher skill and offering more chance of accident.

(2) It seems that a fall of voltage occurring at the same time as a variation of load on the motor (due to throwing over the helm or the natural action of the waves) may make it fall out of step and stop. This has actually occurred on the *Jupiter* and Lieutenant Robinson describes the prompt action ("the turbine is quickly slowed, the excitation of the generator is increased") required to prevent it. Still, might it not be very embarrassing in a storm or when tryng to keep perfect control of the ship if in danger of collision? Perpetual vigilance would be necessary but even then it must take time to re-establish normal conditions. This is the case with the *Jupiter*. Possibly it might have been reduced or obviated.

(3) To get the best results the design and winding of the motor must apparently be somewhat complex.

(4) It requires large air-ducts and fans to carry off about 10 percent of the full power against a simple oil cooling system for the gear.

(5) These air ducts may readily contain water or very moist air, especially when green seas are breaking over the ship. This would almost certainly lead at once to the burning out of any motor or generator it reached. This danger is admitted.

(6) If an engine room had been flooded great precaution would have to be taken before starting the electric apparatus which the water had reached.

As is well known, electrical generators and motors must be carefully dried out before load is applied. This in a large unit is a matter of 12 to 24 hours as a probable minimum.

With non-electric systems there is no corresponding difficulty.

(7) A very delicate governor is necessary.

(8) The engineers, in addition to being expert in steam engineering, must also be expert in electric.

There are some disadvantages peculiar to the *Jupiter* which might be avoided.

(9) The *Jupiter* has only one turbine and generator. Consequently, while she has two screws she has not the advantage of safety which principally led to the introduction of twin screws. If the turbine, generator, or any of their connections break down she is helpless. This is not imaginary for it has already occurred on the *Jupiter*.

If the engine-room space will allow, a second turbine and generator should be fitted on her. If of the same size as those now installed it would bring her weight up nearly to that of the *Cyclops* with her reciprocating engines.

(10) Due to there being only one turbine and generator, both motors must go at the same speed whether they are both going ahead or one going ahead and one astern. Consequently the ship cannot be steered by its propellers, as has frequently had to be done—if the rudder or steering gear is out of service, as has often happened in marine experience, how is the ship to be brought into port?

*No other propulsive system has this great weakness.**

(11) Due to this defect the turning circle is increased (Lieutenant Robinson does not say how much), increasing the liability of collision and the space necessary for fleet maneuvers.

Lieutenant Robinson only claims advantage for the turbo-electric drive in ships of 5,000 horsepower and above. Why the disadvantages become predominant below this power he does not state. The geared turbine can advantageously be applied to all powers and speeds—to slow speeds by double reduction, using which the ratio of reduction may readily be as high as 60 to 1, or more if desired, without excessive size of the large gear.

I have no doubt whatever, after prolonged and careful study of every phase of this most important question, of the great superiority of the geared turbine at full and reduced powers and for every description of ship. That, I believe, is the judgment of a very large majority of marine engineers now, and I feel certain will be the conclusion from experience within a very few years.

Since writing the preceding article I have read Mr. W. L. R. Emmet's paper entitled "Some Comparisons Relating to Electric Propulsion of a Battleship," read last month before the Society of Naval Architects and Marine Engineers, in New York. The paper is only a sketch and no attempt is made to give full information. It contains a number of minor inaccuracies. For instance, the steam consumption of the main drive of the *Jupiter* is given as 11 pounds instead of the published result of the Official Trial Board, 11.68 pounds. Again, "The *California* has two turbines, the *Utah* ten, and the proposed Parsons geared equipment has thirty-two" is neither a full nor a fair statement. The *California* has four turbines, two of which drive the main generators and two the exciting units. If it had four turbines and generators for the main drive, making each shaft quite independent, it would be a much safer ship; so that what he claims as

† *Journal of the American Society of Naval Engineers*, Vol. XXVI., page 350.

* *Journal of the American Society of Naval Engineers*, Vol. XXVI., page 340.

* The *Jupiter* was swung to adjust compasses by going ahead on one screw and astern on the other. Curiously, Lieutenant Robinson thinks this cannot be done with any other form of propulsion. It is almost invariably used to maneuver in narrow waters.

a merit is a serious defect. The weight and space required for the machinery would then, however, have been greater. Also, if he had specified the motive machinery of the *California* as fully as he has that of the *Utah*, he would have added the two electric generators and four motors with their connections, also the two turbine driven exciting units. Further, why go back over two and one-half years to find an extremely complex proposal of Sir Chas. A. Parsons when he must know the much simpler and lighter proposals which have since been put forward?

He states: "At full speed the *California* propellers will make 175 revolutions per minute, this being about the lowest speed of propellers which is practicable within the space. The propeller speeds proposed for the sister ship with Parsons turbine drive is 240 revolutions per minute, and comparisons by Dyson's method indicate that this speed difference will give the *California* an advantage of about 9 percent in propeller efficiency." The inference apparently is that the gear limits seriously the propeller speed available. This is not so, especially in floating frame gears. We may choose independently the most desirable speed of propeller and also that of the turbine and link them up by a suitable gear. In all but comparatively slow ships this is done by a single reduction; in slow ships by a double reduction, as already explained above, but without serious change in weight or in the space occupied.

The *California's* motors can be used with 24 poles or 36 poles. That is the turbines and motors will run full speed at full speed of the ship and also at two-thirds full speed of the ship. This seems to be far from a good arrangement for cruising at half-speed. Indeed, any bipolar arrangement is little more than a make-shift. It seems to make it probable that he will forfeit what he curiously describes as "very heavy penalties" at some of his speeds.

The steam consumption for *California's* main turbine, condensing auxiliaries, and—what do not exist in the geared turbine system—exciting units and ventilating blowers in the engine rooms, is guaranteed to be 11.9 pounds per shaft horsepower hour at maximum speed (22 knots).

The Westinghouse Machine Company's guarantee for a proposed battleship of 64,000 horsepower, for the main turbines is 10.2 pounds per shaft horsepower hour at full speed (28 knots), and they believe they have an eight percent margin. Even without this margin, and adding steam for the condensing auxiliaries, the steam consumption of this battleship will still be well under the *California* guarantee.

The estimated weight of the *California's* "propelling machinery without condensing auxiliaries is 530 tons, and that of the turbines originally proposed was 653 tons." The *California* has 37,000 shaft horsepower, 22 knots, and 175 revolutions per minute of propellers.

The above proposed battleship is of 64,000 shaft horsepower, 28 knots, and 420 revolutions per minute of propeller. The estimated weight of turbines, gears, and thrust blocks, is 212 tons. If it seemed desirable to bring down the propeller speed to correspond with that of the *California*, this could be done without nearly approaching her weight of machinery given above, although the horsepower is 73 percent greater. As the cost per pound weight of machinery would certainly not be greater in the case of the geared turbines, the price of the installation would be less, not 46 percent greater as Mr. Emmet indicates.

The development of the motor and generator was naturally followed by that of the power house. Before its advent the transmission of power to a considerable distance was, if we omit the actual transport of fuel, a practical impossibility; and it made the transmission even within the limits of a factory greatly simpler in many cases. But carrying about the power house and making two transformations of energy, mechanical to electric and again electric to mechanical, before it is applied *in the same room* is surely a development, which could only be justified by greatly increased economy. As I have shown, this increased economy does not exist at high or low power.

It will be readily seen that the conclusions Mr. Emmet desires to impress on the reader are very different from mine, but I submit my figures with the utmost confidence in their accuracy.

Ocean Shipping

Believing that the development of a sound national shipping policy is rendered difficult by the general lack of knowledge of the fundamentals of ocean transportation, the National Foreign Trade Council, of which Mr. James A. Farrell, president of the United States Steel Corporation, is the chairman, has published a monograph entitled "Ocean Shipping." It is a simple presentation of the basic principles of marine transportation with particular reference to the foreign trade of the United States. It is expository and non-argumentative in tone. It compactly presents information from many sources covering aspects of ocean shipping as an industry which have been shown in the discussions of the past year to be little understood in this country. The question is treated from the standpoint of normal conditions rather than those of the present war, it being recognized that the upbuilding of an American merchant marine will be a long task affected by the keen shipping competition of peace rather than the "boom" characteristics of war.

"Ocean Shipping" deals with the merchant marine question as one relating to the establishment of an industry which should add to the national wealth by activity in the world carrying trade. It says:

"Out of 44,000,000 tons of shipping owned in the world, fully two-thirds consist of tramp steamers, of which Great Britain alone owns 70 percent of the whole."

The necessity for the tramp to rove the world over in search of cargoes is vividly described and examples are given of the difficulty of steamers obtaining return cargoes—this problem naturally affecting freight rates.

The enormous advance in freight rates due to the war, which it is stated has removed from private commercial employment between 20 and 25 percent of the total world's shipping, upwards of 9,000,000 of the 44,000,000 tons, by reason of destructive immobilization and impressment for governmental service, is described, but the other examples of the shipping business relate to normal rather than war conditions.

The monograph states that in the chapter on "United States Ocean Freight Bill," an estimate is made of the cost of transportation of the foreign commerce of the United States in the normal year ended June 30, 1914, placing it at $153,520,791 (£31,500,000), of which about 10 percent is estimated to have been carried under the American flag, and the remaining 90 percent, or $138,168,712 (£28,400,000), under foreign flags. Out of this it is estimated probably that not more than approximately $46,848,000 (£9,600,000) was paid by American interests, being the freight on imports in foreign vessels. The freight on exports, as a general rule, is paid by the consumer.

Fig. 1.—Coastwise Collier *Jonancy* on her Trial Trip

Coastwise Collier Jonancy

Tenth Vessel Built by New York Shipbuilding Company for Fleet of 17 Colliers of 126,700 Tons

The New York Shipbuilding Company launched at Camden, N. J., on November 9 the single screw steel collier *Jonancy,* which is a sister ship of the *Virginia,* launched by the same company on October 23. The principal dimensions of these vessels are as follows:

Length between perpendiculars.....319 feet
Beam, molded.....49 feet 3 inches
Depth, molded.....27 feet 6 inches
Draft, loaded.....22 feet 8 inches
Deadweight carried at this draft.....5,450 tons
Gross tonnage .....3,625 tons
Speed at sea, loaded.....10½ knots

The vessel has been built to the order of the Pocahontas Navigation Company, and is of the same type as the *Norfolk,* built by the New York Shipbuilding Company for the Coastwise Transportation Company. The construction is in accordance with the requirements of Lloyd's Register of Shipping and under the supervision of the Coastwise Transportation Company.

This is the tenth vessel built at these works for the same management, bringing the total deadweight carrying capacity of completed colliers up to 70,000 long tons; there are seven other colliers still on order, which will raise the carrying capacity to 126,700 tons for the whole fleet of seventeen vessels.

The vessel has a single deck of steel, with poop 80 feet, bridge 17 feet and forecastle 30 feet long, seven steel watertight bulkheads, two pole masts, straight stem and semi-elliptical stern. A deep double bottom is fitted all fore and aft for the carriage of water ballast, and particular attention has been paid to the construction of this part of the vessel, the plating being of extra strength and fitted flush; no wood ceiling is fitted. A deep tank is also fitted amidships for the carriage of water ballast.

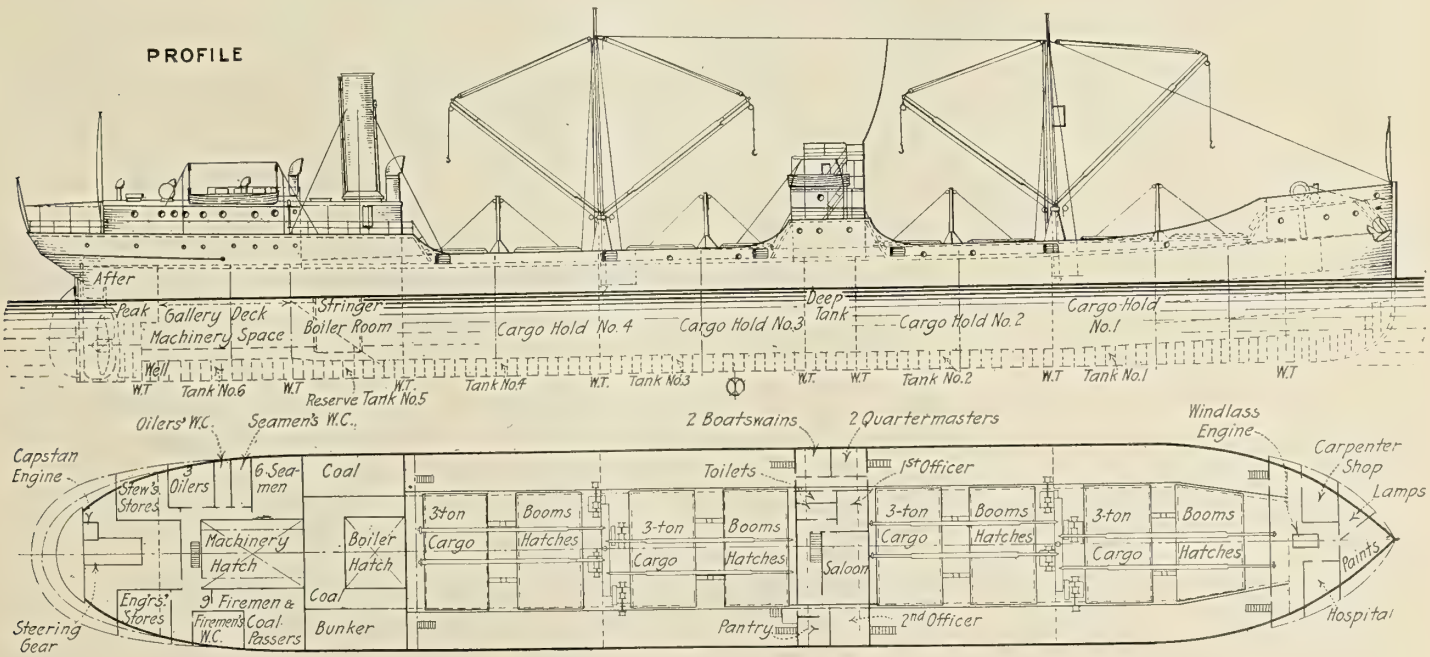

Fig. 2.—Profile and Main Deck Plan

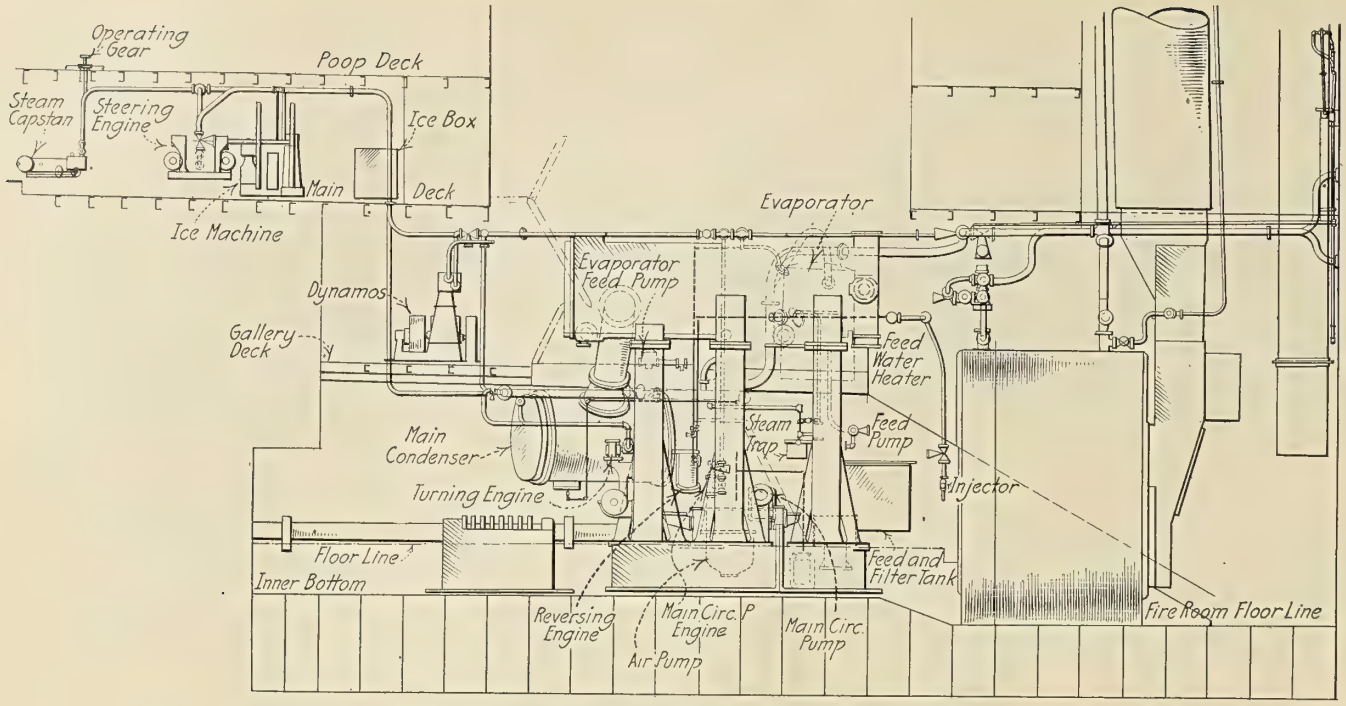

Fig. 3.—Longitudinal Section Through Machinery Space

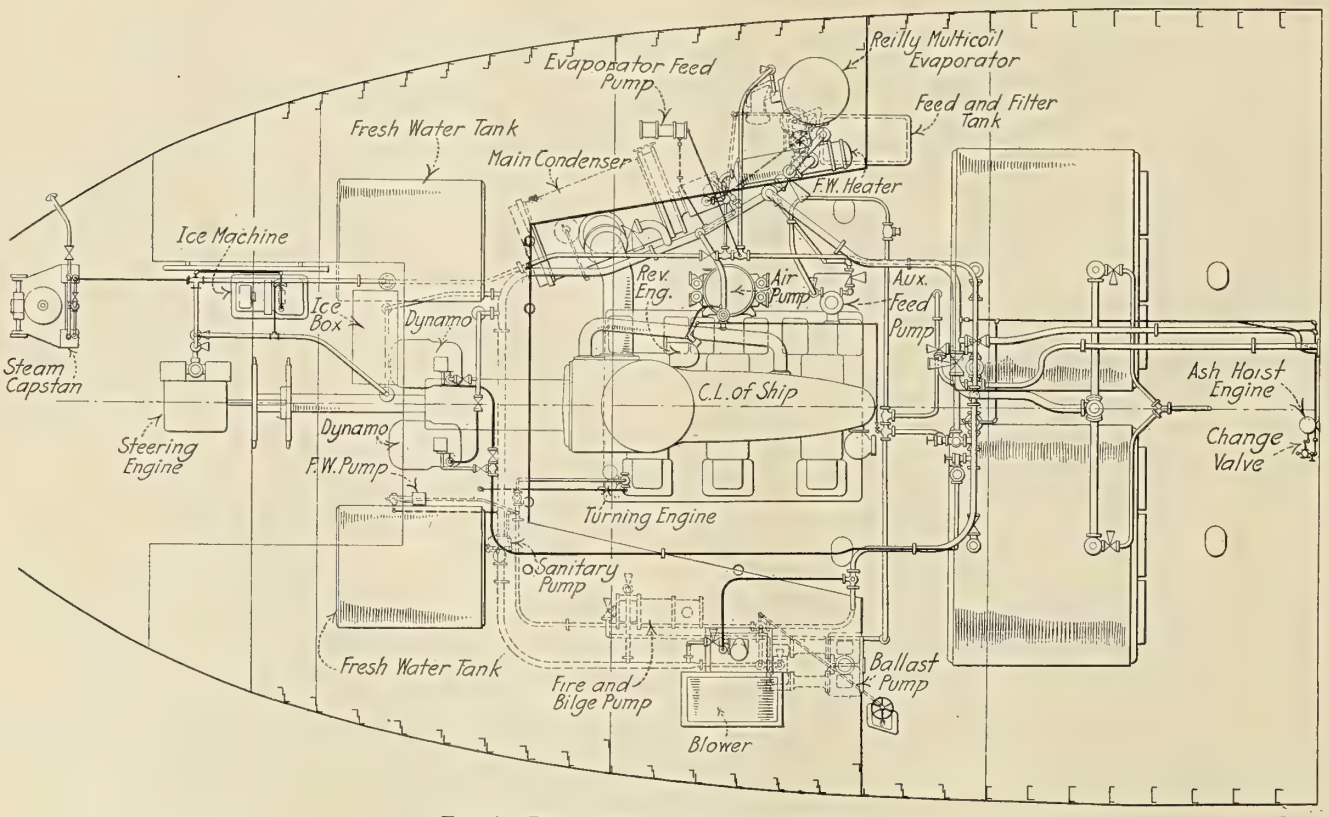

Fig. 4.—Plan of Engine and Boiler Rooms

The four cargo holds are entirely clear of beams and pillars, the deck being supported by deep arched beams and web frames fitted midway between the watertight bulkheads. A continuous trunk 24 inches deep by 28 feet wide is carried on the upper deck for the full length of the cargo spaces, the sides forming strength girders between the bulkheads. Large steel cargo hatches are fitted in top of this trunk, eight in all, two to each hold. Eight steam winches are fitted in connection with two masts fitted with four booms each, for the working of the cargo. Four pairs of king posts for raising the hatch covers and securing them in place when open are fitted.

The coal bunkers are at the sides of the vessel in the boiler room and in the poop 'tween decks, with hatches on the poop deck and pockets leading to the fireroom. The peaks are both fitted as water ballast tanks.

The accommodations consist of a midship deckhouse on the bridge deck for the captain's stateroom and a spare room, with a pilot-house above. The saloon, officers' and petty officers' berths, pantry, toilet, etc., are in the bridge. The engineers, cooks, steward, messrooms, refrigerator, toilets, galley, etc., are in side deckhouses on the poop deck,

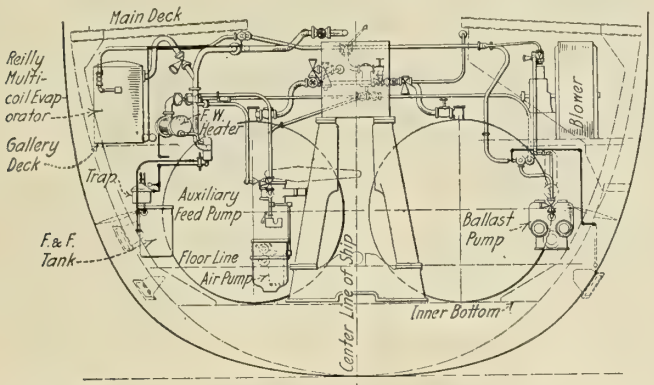

Fig. 5.—Section Through Engine Room, Looking Forward

and the oilers, seamen and firemen are berthed in the poop abreast the engine casing.

A steam windlass is fitted forward with the wildcats and warping ends on the forecastle deck, and the engine fitted below in forecastle. A steam capstan is fitted on the after end of the poop deck, with the engine fitted below. The steam steering gear is fitted on the upper deck abaft the engine casing with connection to the steering stations in the pilot house and on the navigating bridge, an auxiliary

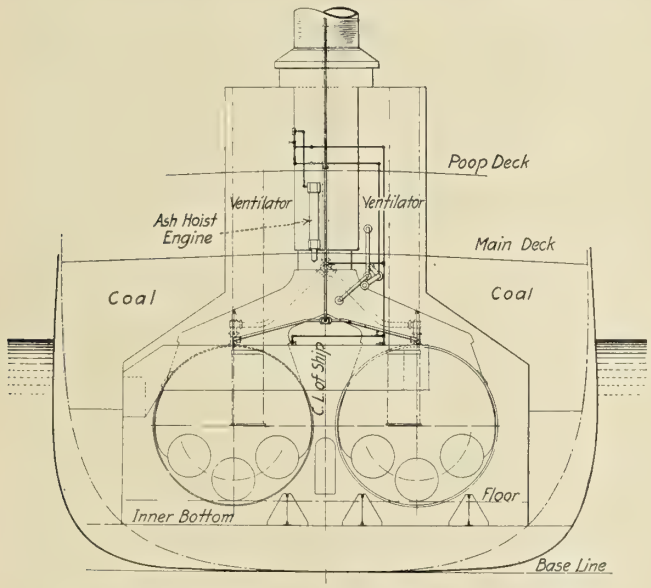

Fig. 6.—Section Through Boiler Room, Looking Aft

hand screw gear being fitted to the crosshead on the rudder stock on the upper deck.

The propelling machinery is placed aft, and consists of one triple-expansion inverted reciprocating engine of about 1,800 indicated horsepower, and two single-ended Scotch boilers having a working pressure of 200 pounds.

The engine has cylinders 21, 35 and 58 inches diameter by 42 inches stroke. The boilers are 14 feet 3 inches diameter and 11 feet long and work under Howden's system of forced draft.

The vessel is intended for the coastwise coal-carrying trade between Baltimore and Boston and is capable of steaming at 10½ knots loaded at sea.

The Drafting Room

BY H. C. ROBINSON *

Shipyard managers from time to time install various systems and are constantly prescribing for improving efficiency in the production end of the yards; studies are made to reduce operation in the shops; various methods are adopted in the form of bonuses and piece work to increase the output; but how many shipyards recognize the value of the drawing room and have looked deeply into the question as to whether work now performed elsewhere in the plant could not best be performed by a technical force of especially trained men before the work enters the yard?

The most unappreciated division in many shipyards is the drafting room. Draftsmen are generally looked upon as necessary evils—as non-producers. Their work cannot be put on a piece-work basis, nor timed, nor accurately estimated. The work on a plan is often greatly involved and the instructions given a draftsman when starting a job can only be in outline. A plan is the product of a man's mind, and no two men make a design alike. One construction will cost more than the other to manufacture; one may be more efficient. This is the human element that cannot be predetermined. It is owing to this perplexing element, possibly, that most systems start where it is plainer sailing, after the plans have been completed.

It is true, there are volumes written on how to conduct a drafting room, and they will be found to contain all manner of schemes to cut down the drafting work and eliminate the draftsman's time—non-productive labor; but very few suggest how more work could be done in the drafting room by men best suited to do that particular work.

It is the intention of this sketch to show that a highly paid drafting force may mean a low cost of production.

A good draftsman is obliged to have a fairly good idea of a number of trades; possess sound judgment on design; an eye for symmetry; have a knowledge of cost for labor and material; ability to plainly and intelligently present on his plan his ideas to others. He must have a good education and acquaint himself constantly with current practice, specifications, building regulations and general information. Otherwise he is obliged to work under instructions of those that do keep posted and who work possibly many hours more than credited for. Men of this type do not long remain draftsmen, for if there is not room further up they generally get out of the business.

While higher salaries would, of course, correct this to a large extent, the impracticability is realized of paying a man exactly what he may be worth; as, for instance, a salesman is paid in proportion to his sales. In large drafting rooms wages must be held within certain limits, and there are many men reconciled to the conditions wherein he receives so much per hour, and as most mechanics, upon receiving journeyman's wages, are satisfied to remain there with no more encouragement than the chance of obtaining at some time or another a promotion in their respective trades, so are these draftsmen working year by year in the drawing room, with the hope that by some action they will receive advancement. There are others, who, fully realizing the difficulties in the way of advancement, work for the self-satisfaction of accomplishing something; work because it is the natural bent of an aggressive human being. These latter are the men for whom every effort should be made to hold. However, possessing the above qualifications, this valuable labor should be most carefully handled to obtain its full worth.

* Chief Draftsman, Hull Division, Philadelphia Navy Yard.

A great mistake is often made in continually hurrying a draftsman. If a man is slow, and that is his only fault, he should be paid accordingly. If he is a loafer, discharge him. A loafer will not exert himself to look up data, to verify information, to make calculation where any chance of failure might take place; to utilize patterns and dies or to study the costs of design. To hurry such a man only makes him leave more to chance and give less thought to the quality and accuracy of his work. The writer has seen in operation an individual curve of performance for each draftsman, whereby a time which was allotted by the chief draftsman for making a plan was shown in comparison with the time actually taken. If the actual time was below the estimated it went to the credit of the draftsman, and vice versa. It will be noted that time is the only element considered. This scheme not only demoralized the force to a certain extent from an ethical standpoint, but encouraged the elimination of careful thought and study. Then again it is taken advantage of if, through some unforeseen circumsctances, the time

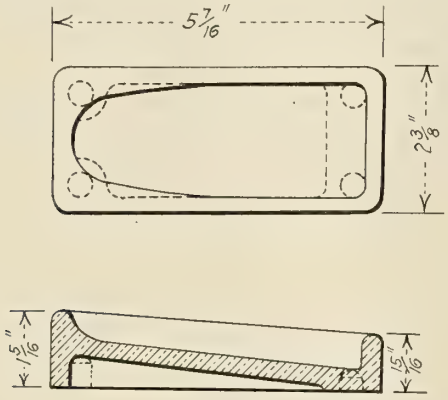

Fig. 1

allotted by the chief draftsman is not required. If the draftsmen were merely delineators, placing with pen and ink the thoughts of others on paper, such a method as just mentioned might be well; but in shipbuilding establishments or navy yards the detail of designs to a great extent is determined by the more responsible draftsmen. Again, the time spent on a plan is often of small consequence compared to whether the plan has been developed to insure the minimum cost to manufacture or the time spent by the dozen men that may be engaged on the job in the yard after leaving the draftsman's table. This is to say nothing of the efficiency of the design, cost of repairs, etc. In this connection it would be interesting to know what percentage of repairs in our navy yards, for instance, is directly due to faulty design originally.

In regard to costs, to illustrate what a draftsman can ultimately cost a concern, is shown by the following example:

A simple casting, as shown in Fig. 1, made to fasten on a shelf to take a rifle butt in its stowed position, was designed and actually a large number of castings were made of scrap brass material, file finished, and fastened with four brass machine screws. Disregarding other means of stowage design, by merely changing the material to semi-steel and fitting one screw at each end, which would have given entire satisfaction, would have saved this particular job approximately $40.00 (8/6/8). As this fitting was turned out of the drawing room in about one hour, it may be seen how much damage could be done in a year by one man. The above is just an instance where the cost of work in the yard was doubled by the design.

The question naturally arises, supposing sufficient inducement to hold an organization were given men of ability, what would be the saving in a year on the total amount of work turned out by one of our shipbuilding plants or a navy yard? It may be noted in connection with the above example that this fitting was developed from a type plan calling for six screws.

With the method of routing work by operations (which is bound to come about in all yards sooner or later), which is another subject entirely, it is necessary to turn out work from the drawing room with every ounce of information for the planner's guidance. In the future, structural plans, joiner plans, etc., will not only be complete in every detail, but put in such form and accompanied by such information to permit its adaptation to the accounting, planning and routing systems of the yard. Such methods add a third more work, in a drafting room at least, over the methods practiced in many of our yards to-day. But, if such a method permits of lower piece-work prices by enabling a man to accomplish more, and also allows of hiring less skilled labor by having the work thoroughly thought out and planned in advance, the comparatively small added expense in the drafting room is of small consequence.

It has been found at the Philadelphia navy yard and carried beyond the experimental stage, as evidenced by the low bid for the battleship recently opened by the Navy Department, that the ultimate cost of production is greatly reduced from the old-fashioned methods where the foreman, his assistants, and down to the mechanic's helper, were deciding questions that should have been decided before the job left the office.

To sum up, the draftsman, by virtue of his position, controls largely the cost of work, and if specially fitted for the work in hand is invaluable to his employer, for they are hard to find. In other words, a high-priced drafting room may mean low cost of production, and when production costs are running high it is suggested that before installing a new system, investigation be made to find if false economy is being practiced in the drawing room.

Annual Motor Boat Show.—Following an unbroken succession of eleven splendid exhibitions, the Twelfth Annual National Motor Boat Show, to be held in Grand Central Palace, New York City, opening January 29 and closing February 5, will eclipse all of its predecessors. There is hardly a type of pleasure motor boat but that will be exhibited at the coming show. Motor-driven river skiffs, power tenders, rowboats, designed especially to be driven by outboard motors, small craft designed for use on inland waters and in sheltered islands, fast runabouts, speed boats of varying design, express day cruisers and commodious yachts, will be shown in lengths ranging from 8 to 60 feet. It is planned to show two 60-foot cruisers, widely different in design and general appearance. Motors will be shown of a wide variety in sizes and types. Practically every engine builder in the United States, and makers of one or two foreign motors which will be shown, have evolved new ideas in the construction of these power plants in their application to various kinds of boats. Refinement of outline, reduction in the number of moving parts, economy of fuel, and many other interesting innovations will be displayed before the delighted public. Accessories, too, will have their departments, and many new inventions and improvements will be put on view for the first time. With the wonderful impetus that has recently come to the motor boat industry in this country, the manufacturers and builders are anticipating that the year 1916 will witness the largest volume of business that has ever been accomplished. Plans are accordingly being made to care for the largest attendance that has yet been known in connection with these exhibitions.

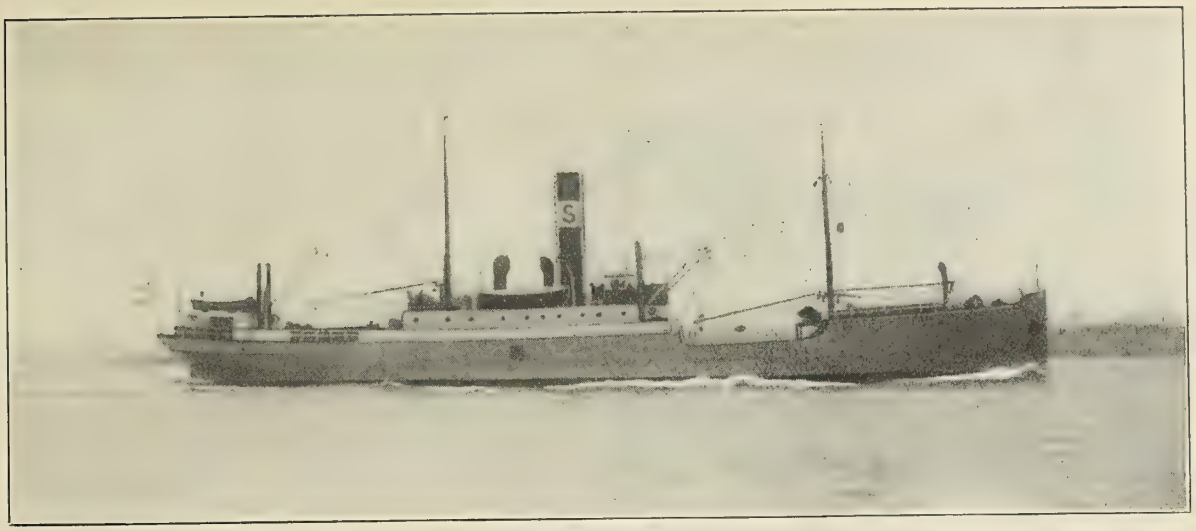

Fig. 1.—Electrically Propelled Steamship *Mjölner*

Electric Propulsion on a Merchant Vessel

Ljunstrom Turbo-Electric Machinery Installed on Swedish Coastwise Merchant Steamer of 2,225 Tons Displacement

As electricity is claiming more and more attention in marine engineering circles as a means for ship propulsion, the following may be of interest as showing how this problem has been approached in Sweden with very satisfactory results in moderate-sized vessels.

The vessel in question, the S. S. *Mjölner,* owned by Stockholms Rederiaktiebolag Svea, is built for traffic along the Swedish coast with Gothenburg as one terminal and Stockholm or some harbor farther north, eventually Gevle or Sundsvall, as the other one, and touching the larger intermediate harbors. In order to be able to maintain regular times of arrivals at the intermediate harbors the steamer is provided with more power than is generally considered sufficient for coastwise steamers. She has a speed of about 11 knots without forcing.

DIMENSIONS OF THE STEAMER

Length between perpendiculars	225 feet
Beam	36 feet
Depth, molded	15.5 feet
Draft at full load	14.76 feet
Block coefficient	0.66
Displacement	2,225 tons

In order to be able to make the speed mentioned above, the machinery must develop about 900 horsepower at the shaft.

The steamer is a single-decked vessel with a bridge deck running straight from abaft the main hatch and with one long back going from the stem to within 8 feet forward of main hatch. Quarters for the officers and crew have been arranged in deck houses on the upper deck midships

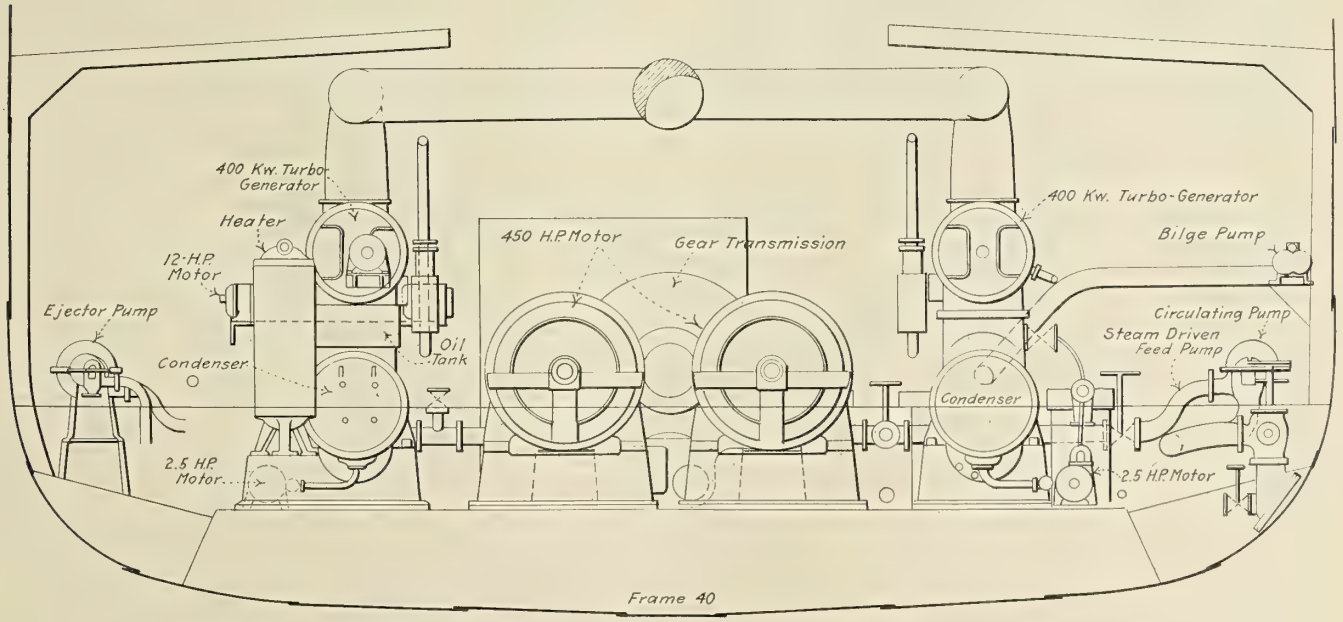

Fig. 2.—Section Through Engine Room, Showing Turbo-Generating Sets, Motors and Auxiliaries

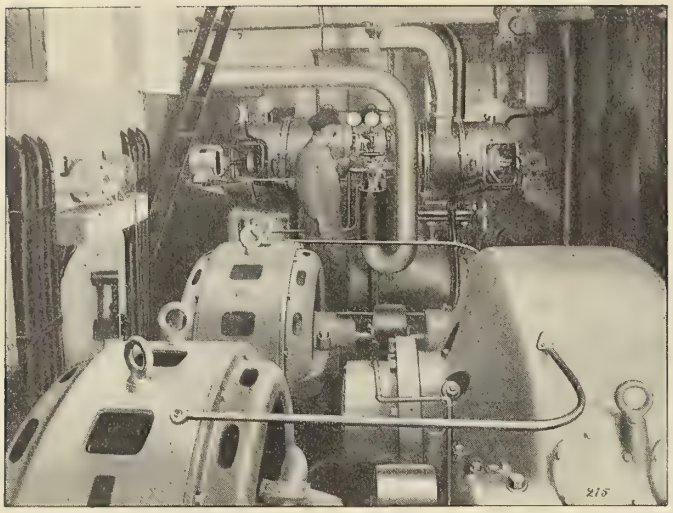

Fig. 3.—View of the *Mjölner's* Engine Room

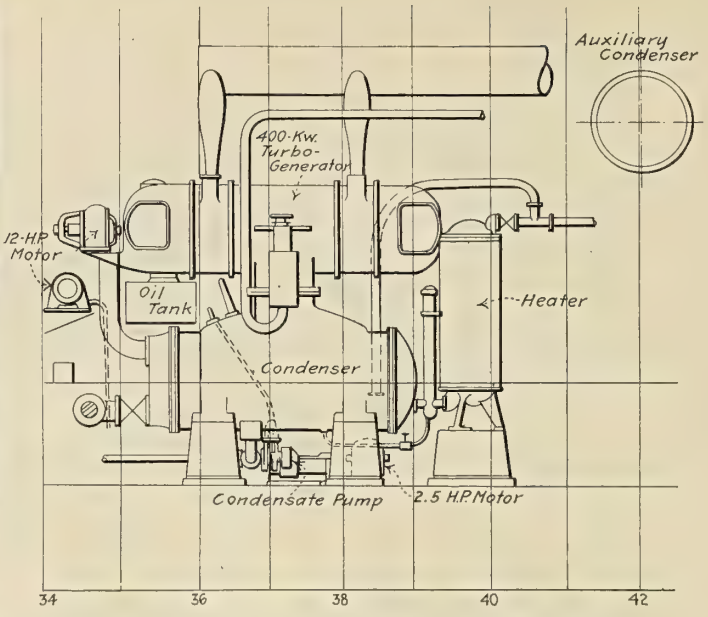

Fig. 5.—Longitudinal Section Through Engine Room

as well as abaft, and also abaft on the main deck.

The vessel is provided with two holds with two hatches for the forward one and one hatch for the after one and five steam winches with booms necessary for loading and unloading.

Although the steamer is classified in Bureau Veritas, I ✣ 3/3 G. I. I. P. R. A. & C. P., the dimensions of the stem, the propeller frame and the rudder are at least 25 percent and of the planking at the ice belt at least 10 percent in excess of the requirements of her class, so as to provide extra strength for navigation in ice. There is a continuous double bottom from stem to stern arranged for water ballast, except under the boilers, where the tanks are dry.

The Ljungstrom Turbo-Electric Machinery

This plant is made up of two similar units, each consisting of one 400-kilowatt double rotation turbo-generator working at a speed of 7,200 revolutions per minute and generating three-phase alternating current at 500 volts and 120 full cycles per second. The generated current is used to drive two three-phase motors, which in their turn drive, through pinions with inclined teeth, a common gear fastened to the propeller shaft. The motors make about 900 revolutions per minute and the propeller shaft 90 revolutions per minute.

Each turbo-generator unit, consisting of one turbine and two electric generators, is mounted directly on top of an ordinary surface condenser and is provided with elec-

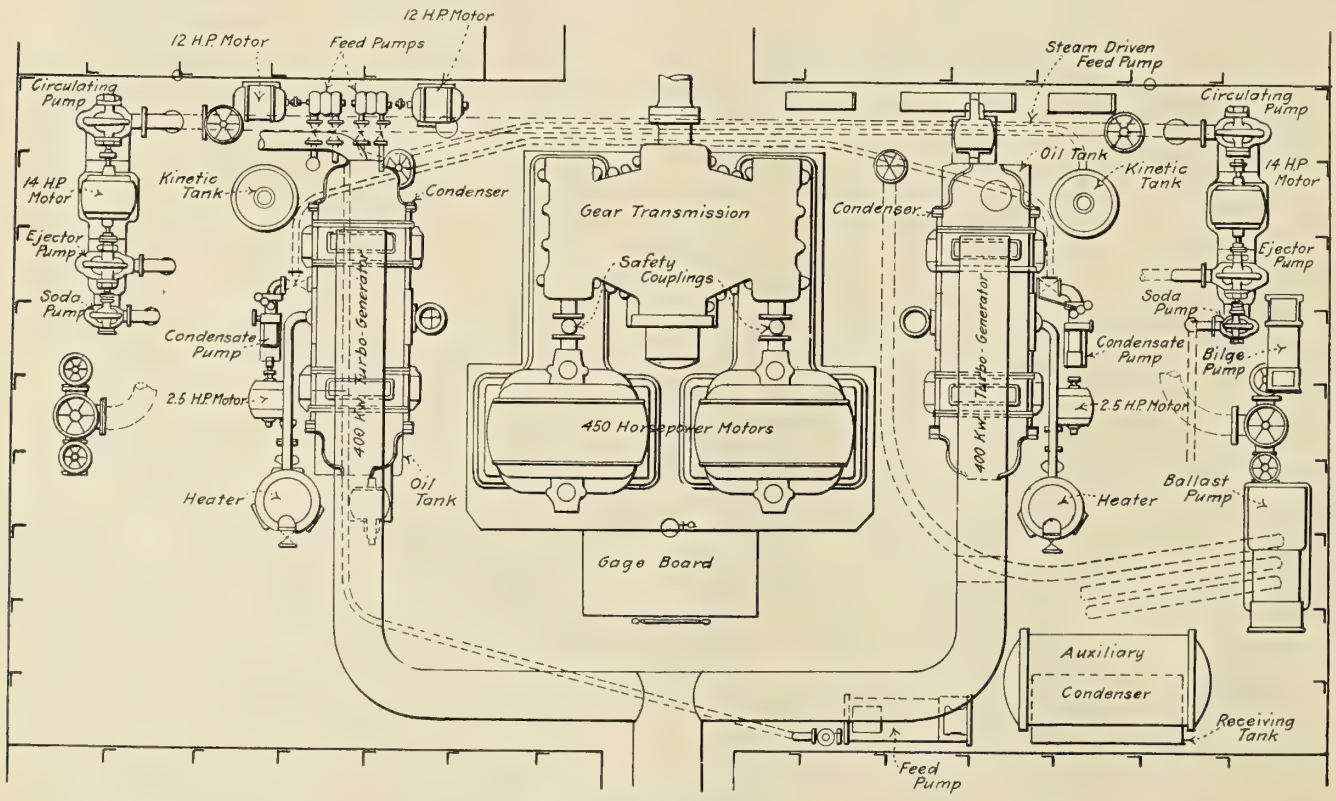

Fig. 4.—Plan of Engine Room

trically driven air, circulation and feed pumps. The air pump is of the dynamic jet type and the two other ones of the centrifugal type.

The condenser is of the counter-flow marine type with a liberally dimensioned cooling surface, which allows 95 percent vacuum at full speed. The above-mentioned pumps are so arranged that they may be used for only one of the generator units as well as for both, whereby the danger of complete breakdown of the machinery is considerably minimized.

The bilge pump is independently driven by steam.

The maneuvering is accomplished by electrical means. The speed is regulated by cutting out or in resistances in the motor fields and reversing is by changing the pole phases. When the generators from one cause or another are unloaded, the automatic regulator cuts off the steam in corresponding degree.

The pressure from the propeller is taken up by a ball bearing at the forward end of the shaft which carries the common gear, but besides that there is a bearing of the common thrust type, which is brought into action if the ball bearing should fail.

The lubrication of the moving parts of the generators and auxiliary machinery, as well as the gear transmission, is done automatically.

The steam required by the turbo-generators is furnished by two boilers of the common cylindrical type at a gage pressure of 218 pounds per square inch and a superheat of 235 degrees. The boilers are 10 feet 10⅛ inches diameter and 10 feet 8¾ inches long, and have a total heating surface of about 2,129 square feet (exclusive of the superheater) and a total grate surface of 58 square feet. Each one of the boilers has two corrugated furnaces, 35 inches inside diameter, and is provided with Howden's forced draft and Wm. Schmidt's superheater.

The air for the forced draft is obtained from the generators by ducts leading the ventilating air from the rotors to the smoke chamber, where it is heated in the ordinary way before it is brought into the furnaces.

The superheater has a total heating surface of about 770 square feet and is divided into 48 sections. The boilers also supply saturated steam to the steering machinery, to the engines for the electric lighting, to the tank, feed and donkey pumps, to the ash ejector and the deck auxiliaries. The feed water is led through heaters and filters before it re-enters the boilers.

In order to protect the main condensers from grease and dirt from the steam-driven auxiliaries and deck machinery, an auxiliary or winch condenser is installed with all necessary piping.

Safety Couplings

As the vessel has to navigate in ice-filled waters, a safety device is introduced the function of which is to prevent the breaking of the propeller shaft or stripping of the gear teeth. This safety device consists of friction couplings located between the motors and the pinions.

The maneuvering arrangements are so made that one man alone can take care of the machinery without difficulty.

Efficiency of the Machinery

By using the above described turbo-electrical driving method, it has been possible to design each one of the various parts of the machinery, such as the turbines, motors and propeller for the most suitable speed and other requirements. The plant thereby obtains the highest efficiency throughout, resulting in 42.3 percent less coal consumption than the sister boat *Mimer*, which is equipped with common reciprocating machinery. The guaranteed saving of coal was 30 percent.

Furthermore, the available space for cargo is considerably increased, not only as a consequence of the comparatively small space required for the turbo-generators themselves, but also due to the reduced coal consumption the incidental machinery, such as coal boxes, boilers, etc., is smaller.

The earning capacity of the vessel is consequently considerably increased throughout, which in connection with the decreased expenses for fuel will materially increase the net earnings.

Coal Handling Equipment at Pittsburg and Conneaut Dock

Last year the McMyler-Interstate Company built at its works at Bedford, Ohio, for the Pittsburgh & Conneaut Dock Company, a subsidiary of the United States Steel Corporation, at Conneaut, Ohio, a car-dumping machine designed to handle 100-ton cars. The machine is provided with a disappearing haulage car, so that the haulage car runs backward under the loaded car, and in this way climinates the delay which would be occasioned by holding the loaded car on the incline until the haulage car had reached the pit.

Car Dumper at Conneaut Docks

The machine is electrically operated in all the smaller movements, while the large units are operated by steam. Electrical operation affords better control and makes it possible to deliver the coal in the hold of the vessel with minimum breakage and delay. The operator can raise or lower the inner or outer end of the pan, swinging the telescope back and forth and revolving the trimmer all simultaneously. The machine is also provided with counterweights so as to reduce the amount of power required to operate it.

Three hundred and fifteen cars of coal have been transferred from the cars to vessels in seven hours—an average of 45 cars per hour.

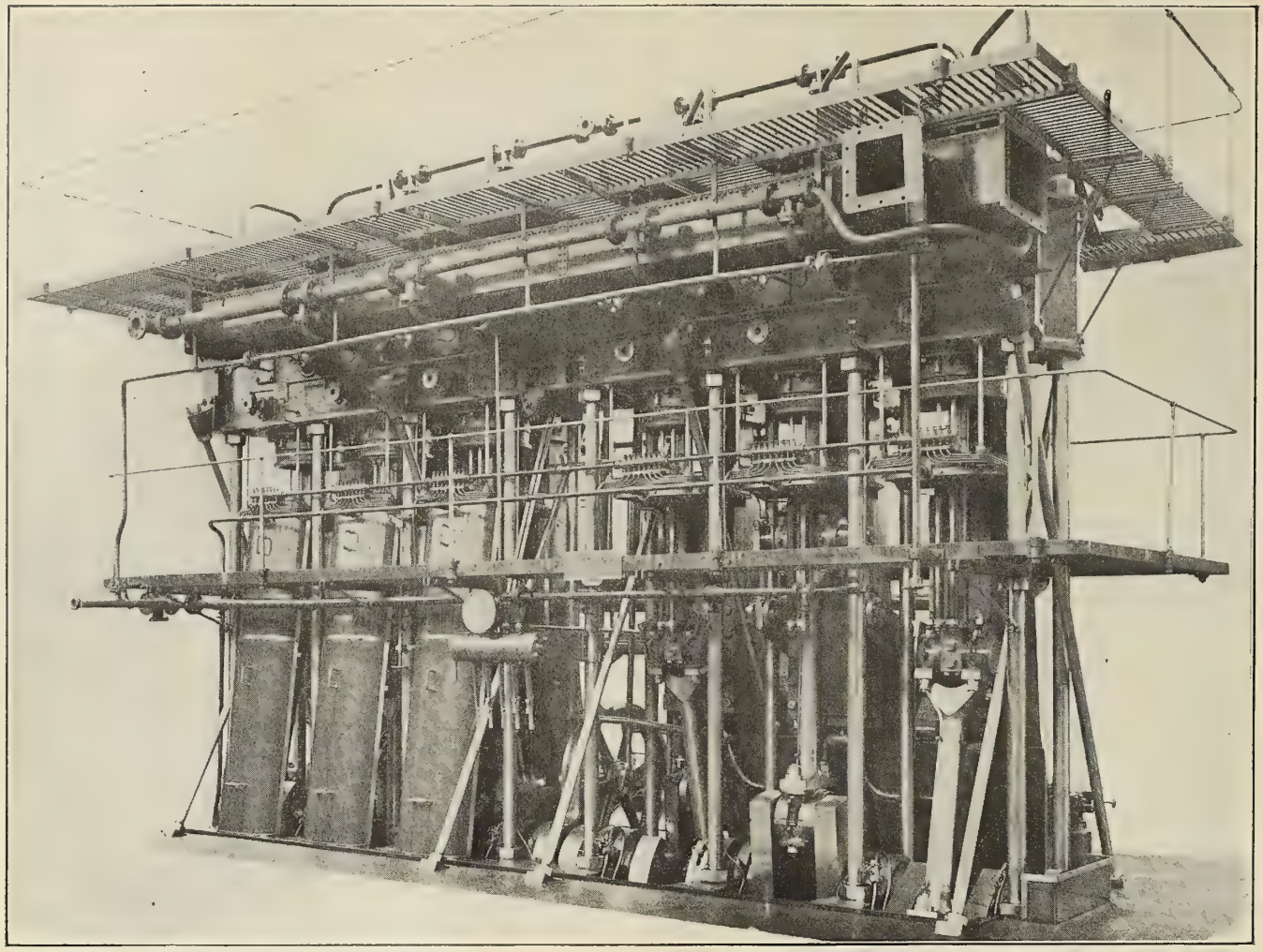

Fig. 1.—Werkspoor Marine Diesel Engine of 1,500 I. H. P. at 120 R. P. M.

The Werkspoor Marine Diesel Engine

Description of a Diesel Type Motor That Has Been Installed in Twenty-Two Sea-Going Commercial Ships

BY J. RENDELL WILSON

It is not generally known that the Werkspoor-Diesel engine since its inception has been installed in more ocean-going commercial ships than has any other make of Diesel engine, it having been installed to date in twenty-two vessels having a deadweight carrying capacity of over 40,000 tons and a total output of about 33,000 indicated horsepower. While many more Werkspoor-engined vessels are building, several of them are of only 250 to 500 brake horsepower, as the builders of the engine have preferred to develop the engine gradually instead of starting with high powers. Even after six years' experience with marine Diesels and fifteen years' construction of land Diesels, the Werkspoor Company has not to-day gone higher than 2,000 indicated horsepower per engine, although, of course, this does not apply to the near future.

One remarkable fact about the construction of high-powered Werkspoor marine engines is that all their recent ocean-going ships up to 3,000 horsepower per vessel in twin screws have had their motors installed directly into the hulls without even turning the engines over in the shops, not to say testing them on the brake, which was only done with the earlier engines. These motor ships merely receive a few hours' sea trial, and then are sent on twenty- and forty-days', non-stop ocean voyages. Many have gone to the Dutch East Indies, where they have remained in regular service.

Some technical details of the Werkspoor engine doubtless will be of interest, especially as it is the oldest of the sea-going Diesel engines, it having been installed in the Anglo-Saxon Petroleum Company's tanker *Vulcanus* in 1910, since when these owners have acquired eight other ships powered with the same make of motor.*

The engine illustrated, and which we propose to describe, is the 1,500-indicated horsepower model, which develops 1,100 brake horsepower at about 125 revolutions per

* When the Werkspoor Company first turned their attention to the marine Diesel engine, they decided that unless an engine can be repaired in any port of the world where steam engines can be repaired, it is of no use for ocean-going ships. To the present day they have adhered to this sound policy, consequently there is nothing fantastical about their design—in fact, from the bottom of the cylinders downwards it is exactly similar to an ordinary marine steam engine.

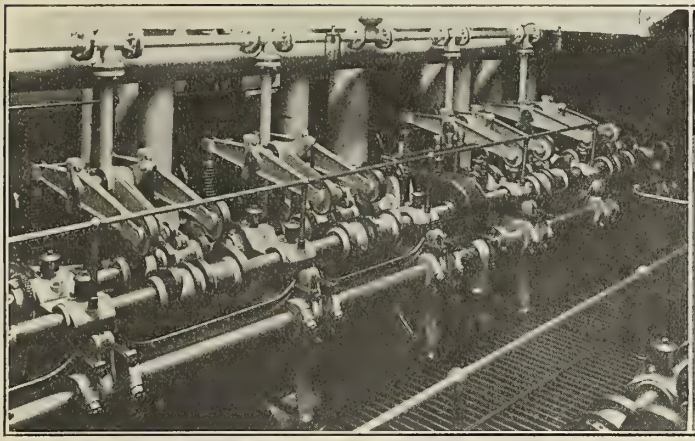

Fig. 2.—Valve Gear, Showing Ahead and Astern Cam Shafts

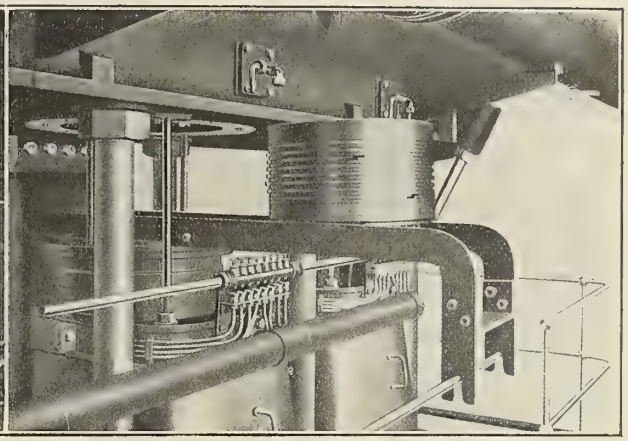

Fig. 3.—Method of Removing a Piston

minute from six single-acting cylinders, each 22 inches bore by 39⅜ inches stroke, and with a weight of about 122 tons. Its length is 27 feet 3 inches by 8½ feet width and 16 feet 9 inches high above the crankshaft. It will at once be noted that it is an engine in which accessibility has almost been brought to an unusual condition by reason of it being quite of the open crank-pit type, with the cylinders mounted on steel columns, etc., while strength and rigidity are added by steel cross-stays, with the cross-head guides on cast iron frames at the back of the engine. To the steel columns detachable steel plates are fitted to prevent the lubricating oil being thrown out by the connecting rods. The six working cylinders are divided into two sets of three, with the cam-shaft driving gear and all the control levers between.

One of the exclusive features of the Werkspoor design is to be found in the arrangement of the cam-shaft operating gear. At the back of the engine, just over the bed-plate, is a small lay crankshaft operated by two-to-one reduction spur-gearing off the main crankshaft. On this lay-shaft there are four crank-throws, and the motion is directly transmitted to similar crank-throws on the ahead cam-shaft (which is mounted in brackets on the side of the cylinder head) by means of four hollow, girder-shaped rods, and so the cam-shaft is given a gentle, even and continuous rotary motion, each throw being set at right angles to the others. These rods are really steel tubes, split down through the centers and held apart by cross struts, which, it is claimed, eliminate all vibration.

Now there are two cam-shafts, one for the ahead running and one for the astern movement, and the astern cam-shaft is driven by means of spur gearing from the ahead cam-shaft, while the two shafts are mounted on sliding brackets. When maneuvering, these brackets, by sliding to and fro as desired, bring the ahead or astern cams under the rollers of the valve-rockers. By making these rollers unusually large, the angle of the face of each roller where it meets its cam is never steep, and this produces smooth and silent running. Thus reversing is rapidly and quietly carried out. On ships in service the time occupied to reverse from full ahead to full astern is from five to ten seconds, this depending upon the smart-

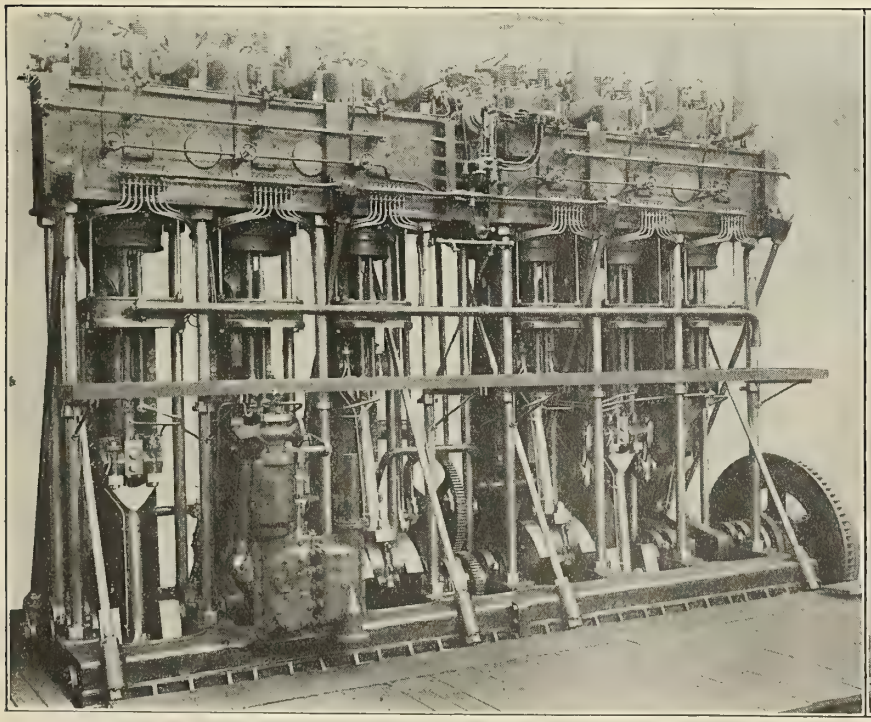

Fig. 4.—Back of Werkspoor 1,500 Indicated Horsepower Marine Diesel Engine, with Splash Plates Removed

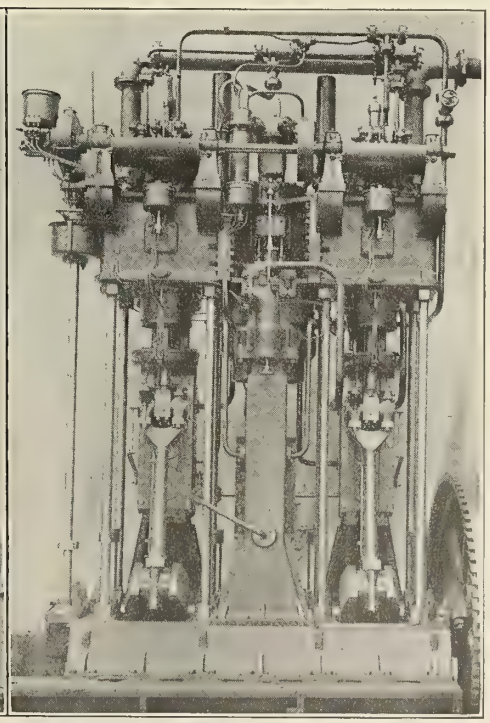

Fig. 5.—Werkspoor 2-Cylinder, 100-Horsepower Auxiliary Diesel Engine

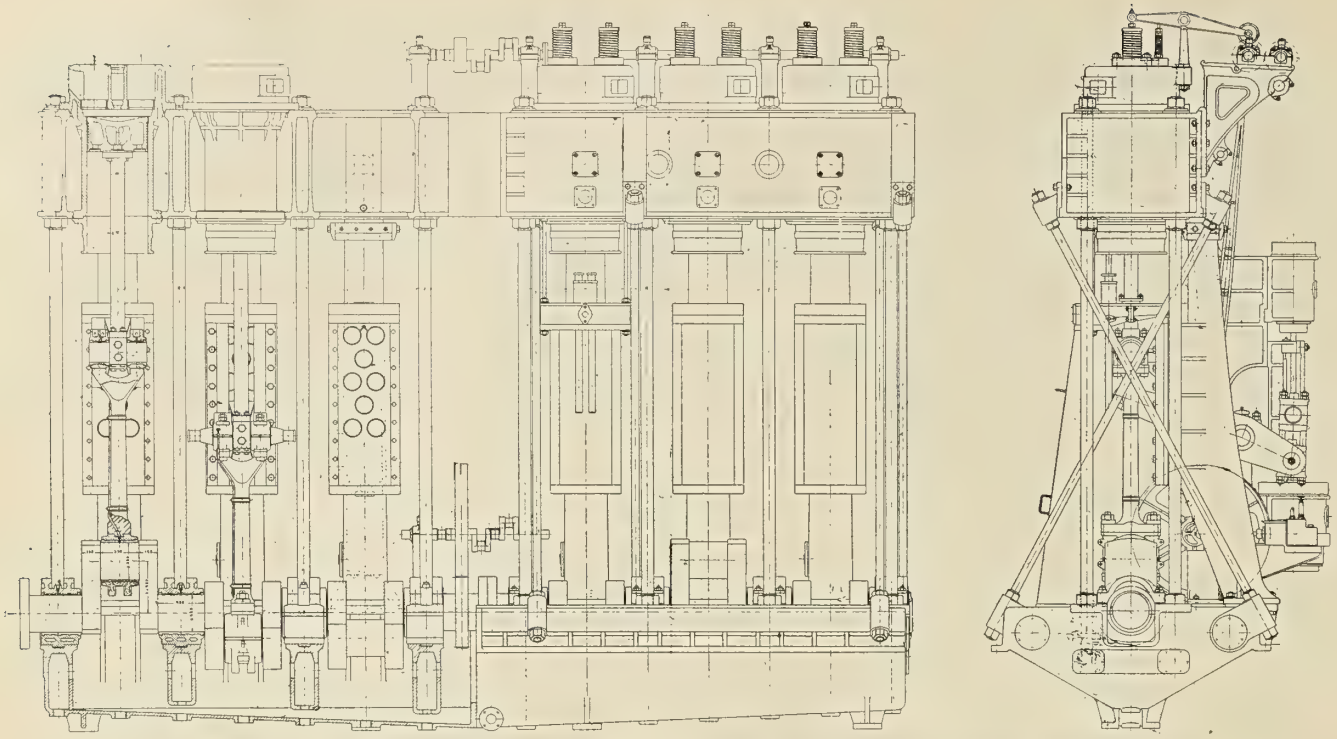

Fig. 6.—Plans of 1,500 Horsepower Werkspoor Diesel Engine, Showing Section Through Working Cylinder

ness of the engineer-in-charge. To start up from cold takes three to five seconds.

In view of the fact that the four coupling-rods would seem to require an arc for their lateral travel, unless they became buckled by the downward pressure, it is best to mention how the difficulty has been neatly overcome: the lower brasses are made with play and clear the pins when the two shafts are in the center of the chord; i. e., the mid-gear position, coming back into contact when the shaft is in the running position for either ahead or astern motion—the rods never push, but only pull.

Regarding the air-starting arrangements, it is interesting to note there are relief-valves fitted to the cylinders to reduce the compression internally; furthermore, there is a sleeve fitted to each air inlet pipe, so that the inlet can be closed and no atmospheric air admitted to the cylinders until the engine gets under motion. This sleeve is interlocked with the control gear. Thus this big engine can be started on a pressure of 250 pounds per square inch, which means great economy of compressed air, a very important point too often overlooked. The air-starting valve cam has a double "lift," one to allow of the valve being slightly opened, such as when the engine is hot, and does not require much air to get away under load. The larger "lift" can be brought into action should the engine be cold and refuse to pick up the load with a small quantity of air. To prevent sticking of the fuel valve there is a little automatic device, which closes it, should it happen to remain open by any chance.

Most Diesel engines have a separate fuel-pump to each cylinder, which are regulated by opening and closing the individual suction valves, and this method the Werkspoor firm considers requires too delicate an adjustment to supply exactly the same quantity of fuel to each cylinder, so they have fitted a single pump, which supplies two distributing boxes, each box having feeds to three cylinders, while every feed has its own adjuster. To the exhaust branch from each cylinder is fitted a thermometer, so that by reading the temperature the engineer can instantly see if any one cylinder is receiving more, or less, fuel than the others. As a standby an extra pump with a simple change-over device is fitted.

The fuel-pump does not supply the distributers direct, but first feeds a reservoir in which an air pressure is main-

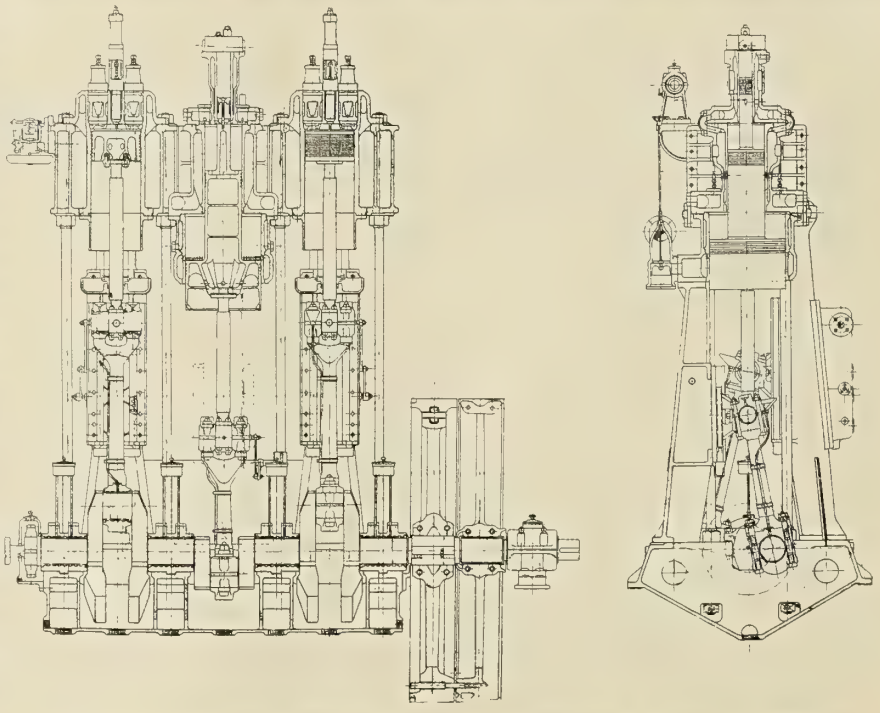

Fig. 7.—Two-Cylinder Auxiliary Engine. Air Compressor is Between the Working Cylinders

tained, thence the oil passes through a governor-controlled throttle, a hand throttle, and through master valves, and finally into the distributers. The receiver holds enough fuel to run the engine for 15 minutes, so that in case of a breakdown of the fuel-pump the spare pump can be connected up before the engine stops, which is not possible with any other design. The distributing boxes are quite close to the indicator cocks, so that adjustments may be made by the engineer in charge while he is reading the cards and thermometers, so accurate setting can be obtained. To ensure reliability, the plunger fuel-pump is made from a solid steel forging; the valves are simply steel balls, and the gland runs in an oil bath.

From the sectional drawing it will be noticed that the cylinder proper is separate from the outer jacket, which is a simple box-casting.

An important part of the design is that the cylinder liner which extends below the jacket is detachable, and may be unbolted, thus facilitating the easy removal of any piston without dismantling any portion of the engine, and so saving many hours of tedious labor. The pistons are water-cooled, this being carried out by means of clearance pipes and a pressure jet. Both these are exclusive and patented features.

Unlike the majority of Diesels, forced lubrication has not been adopted with the Werkspoor, and, except for the cylinders, the system used is entirely sight-drip-feed lubricators. To avoid overlubrication, light steel plates are fitted in front of the connecting-rods between the columns, to catch the splashes and direct them into the center sump of the crank pit, whence the oil is pumped through a filter and cooler on the engine-room walls, from which it is returned by gravity to the numerous sight feeds.

Regarding the three-stage air compressor, this is driven off the fifth cylinder by means of a link and beam lever on the crosshead at the back of the engine, and the water-cooling and bilge pumps are driven in a similar manner off the forward three cylinders. The after cast iron column is utilized as a cooler for the air compressors, the air circulating through water-cooled coils contained therein. A relief valve is fitted to the column to prevent damage should one of the coils burst, and at the top of the column there is a water overflow valve.

Thus it will be seen that the Werkspoor design is self-contained and does not require a large amount of separate Diesel-driven auxiliary machinery to run the engine, particularly as the exhaust gases are led to a donkey boiler, and sufficient heat is obtained to maintain a pressure of 100 to 120 pounds when at sea, and thus economically operate the auxiliaries. Yet the engine of the *Juno* (which is similar to those installed in the *Emanuel Nobel*, *Elbruz* and *Siberg*, only the latter two ships have modern improvements added to their engines) gave 1,460 indicated horsepower at 115 revolutions per minute, or 1,140 brake horsepower with a mechanical efficiency of 78 percent, the mean effective pressure being about 105 pounds per square inch. Some of the cards have shown a mean effective pressure of 126 pounds per square inch.

Although often termed crude oil, very little fuel of this nature is used by Diesels, owing to the presence of the light carbons, but what is really used is residual oils; that is to say, the oil after the gasolene (petrol), kerosene (paraffin), etc., have been extracted. But the *Juno* and *Vulcanus* have successfully run on Taraken, which is crude oil, with a specific gravity of about 0.94. The general consumption of Werkspoor-engined ships in service has been about 0.30 pound per indicated horsepower hour.

The fuel question is, however, a most important one. Very heavy oils can be successfully used, but under such conditions a lighter fuel, such as Solar oil, must be used for starting, and for about 15 minutes each day the engine should be run on the lighter oil, in order to clean the fuel injection valves and combustion chambers. At the same time where the lighter grades of fuel oils can be obtained at about the same cost as the very heavy oils, their use is advised by the makers, as it is foolish to use oil full of foreign matter and so thick that it has to be heated before it will follow the stroke of the fuel pump.

To illustrate what a Diesel engine can consume, we may add that at the Werkspoor works a test motor ran without trouble and for a considerable period on Mexican crude oil of the following analysis:

Specific gravity at 15 degrees C	.862
Flash point (closed test)	140 degs. F.
Calorific value	17,430 B. T. U.
Sulphur	4.6 percent
Asphaltum	70.0 percent

This, of course, is an exceedingly heavy oil. It was only successfully used under the most favorable conditions, and the Werkspoor Company would be the last to advise its use under average seagoing conditions. Contrary to the general impression, the presence of sulphur in the oil does not cause an ill effect on the exhaust valves and cylinders, provided, of course, proper care is taken.

Lastly, we will say that we have been advised that none of the Werkspoor-engined ships placed in service during the last year or two has suffered from cracked cylinders or cylinder heads, which is, perhaps, a pleasant revelation. Naturally, with the earliest ships some trouble was experienced from this cause, but the makers were enabled to discover the reason for the cracks, and a change in the design entirely eliminated the difficulty. Recent ships have proven themselves to be thoroughly reliable. It is only fair to add that even the cracks that arose with earlier engines did not prevent the engines from continuing working without new cylinders, so that, while the Werkspoor Company afterwards changed such castings, it was not really necessary.

CONNECTICUT RIVER IMPROVEMENT.—Federal improvements of the Connecticut River from Hartford, Conn., to Holyoke, Mass., to provide a 12-foot channel at a cost of $1,870,000 (£384,000) have been recommended to Congress by the Army Engineering Board. The construction is conditional upon the construction of terminals at Hartford, Holyoke and Chicopee, and also upon the construction of a lock at Enfield by private interests.

OFFICERS OF THE NATIONAL BOARD OF STEAM NAVIGATION.—At the annual meeting of the National Board of Steam Navigation, held in Washington in December, E. F. Moran, New York, was elected president; J. Frank Tilley, Pittsburgh, first vice-president; W. E. Bernard, Philadelphia, second vice-president; E. A. Burnside, Point Pleasant, W. Va., third vice-president, and Captain N. L. Cullin, New York, secretary-treasurer.

NEW SWEDISH SHIPYARD.—According to press reports a large new shipbuilding yard is to be established at Landskrona by a Gothenburg firm. Between 600 and 700 men will be employed and the municipality has agreed to carry out the preliminary excavations at a cost of $102,600 (£21,000).

SWEDEN PROHIBITS THE SALE OF VESSELS.—The Swedish government has prohibited the sale of Norwegian vessels to any foreign country, although the law may be waived in special cases.

(From The Commercial Vehicle)

Fig. 1.—A Typical Line-up at One of the New York City Piers. Note Light Electric Motor Trucks in Right-hand Background, waiting with the Rest. Attitudes of Drivers Tell a Story in Themselves

Motor Trucks as the Solution of the Marine Freight Terminal Problem

Savings in Time and Costs Made Possible by Use of Motor Trucks at Marine Terminals—Congestion of Freight

BY MERRILL C. HORINE *

Four-fifths of the cost of freight transportation in the United States represents terminal charges. It costs less to ship a ton of freight via water from Savannah to New York than to transfer it from the vessel's hold to a Brooklyn warehouse, inland. The business of the carrier is to transport merchandise, which nearly all of them do with astonishing efficiency and at surprisingly low cost.

The present freight tie-up in America arising from heavy export shipments occasioned by the war proves that the business of the carrier also includes terminal work and that without corresponding efficiency in this branch of its work, that of the other and chiefest work goes for little.

Of what avail is it that a company be prepared to transport a cargo quickly, safely and cheaply if it cannot get that cargo without vexatious and costly delay? The carrier's business begins when he receives the goods at his terminal, and ends when it is carted away from its other terminal.

Modernize terminal and street transportation having a direct connection with marine transportation and your problem is solved. The most modern and efficient means of short-distance transportation to-day is the commercial motor vehicle.

To appreciate the bearing of the motor truck on the marine-freight-terminal problem it is first necessary to consider the relation of the motor truck to present freight-carrying appliances.

There are approximately 2 million freight cars in service on American railroads. These freight cars haul annually about 2 billion short tons an average of 137.5 miles or 275 ton-miles per year. Of this enormous tonnage, a portion goes to make up the annual freight tonnage of ocean vessels into and out of United States ports—approximately 600 million tons annually, or one-third.

This third represents, then, the total tonnage of merchandise handled by marine freight terminals in this country. As such it also represents what is handled under the most adverse circumstances, for our marine terminals are the ones where the greatest volume of matter has to pass over a given area of platform in a given time.

A steamship is unloaded, coaled and provisioned and then reloaded in the minimum possible time because of the tremendous investment represented by the vessel, which is entirely wasted every hour it stands idle. A vessel is only earning when it is transporting goods, and for this reason every possible means is, or should be, used to speed up the loading and unloading operations. It costs between $40 and $45 (8/6/8 and 9/7/6) an hour to hold the usual size of coastwise steamship in port. This is not only indicative of the occasion of the great traffic over steamship bulkheads in a short time, but also of the importance of using every means possible to avoid delay at the terminal.

There are not much over 120,000 motor trucks of all classes in use in this country, and not any great proportion of these are used in connection with freight-terminal

* Associate editor of *The Commercial Vehicle.*

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work. To handle all of the 600 million tons which annually pass over the marine bulkheads—2 million tons every day of a working year of 300 days—would require about 20,000 motor trucks, working at their maximum ability. But a great portion of this freight never reaches the street; it is transferred directly to freight cars, lighters or warehouses.

Of 2 billion tons of freight handled annually by the railroads, 120 millions are package freight, or less carload lots (l. c. l.). Assuming the same proportion of bulk to l. c. l. freight to hold good in marine freight, then one-sixth of the total marine freight per day, or 333,333 tons daily, must be taken away from marine terminals by street vehicles. Thus only 3,333 motor trucks, or we will say, allowing for an adequate reserve, 3,500 will be required to accomplish this work.

This contemplates a daily tonnage of close to 100 for each truck. If the average haul is 2.5 miles each way and the average speed throughout the day 5 miles per hour and the loads approximately full in both directions, this would be realized, 10 tons being transported each of ten trips per day.

Perhaps it may be a point for legitimate doubt if a motor truck could rise to such astonishing effectiveness under present conditions of traffic in New York, Boston or Philadelphia, but investigation will disclose that the present inability of motor trucks to even approximate such a performance is due not so much to street-traffic conditions as to loading and unloading delays encountered.

It is necessary to estimate the work of motor trucks under an ideal terminal transport scheme because the number at present used in such work is negligible.* We have a good basis to work on, however, in determining the efficiency of horses. A horse dray with a two- or three-horse team carries about 4 tons in a city of average grades. It can travel a maximum of 15 miles per day with good

* Investigations conducted by the author have shown that in the fall of 1912 motor trucks constituted 3 percent of the trucking from Chicago freight terminals. In New York, in the summer of 1913, 7 percent of the freight terminal traffic observed was by motor.

(From The Commercial Vehicle)

Fig. 3.—Why the Wagons Must Wait. Here the Goods are so Congested Within the House That There is No More Room to Unload, so That It Takes Abnormally Long for Each Vehicle to Discharge Its Load and Get Away, Meanwhile Delaying Others

loading and unloading conditions. But, with these as they actually are, horse wagons in this service make but 9 miles average per day, or about two trips. Also, at present, they do not as a rule carry full loads, the average being about half the capacity of the vehicle, outbound freight being slightly more than this, and inbound correspondingly less.*

Thus, with a 2-mile to 2.5-mile haul, each wagon will haul some 4 tons per day in each direction, or 8 tons daily. However, the load factor, too, is very poor, the outbound load being generally much less than the inbound load, so that perhaps each wagon will not average over 6 tons daily. Thus, to handle the 333,333 tons of matter would require 55,555 drays, or, allowing for a reasonable reserve, 60,000, and 120,000 to 130,000 horses.

* Based on investigations in Boston by Harold Pender, H. F. Thomson and H. F. Eldred, for the Massachusetts Institute of Technology, and presened before the New York Railroad Club, September 18, 1914.

(From The Commercial Vehicle)

Fig. 2.—A Clear Platform on An Efficiently-Conducted Pier (The Fall River Line, Pier 14, New York City). Electric Industrial Trucks Take All Freight Away From the Narrow Platform As Soon As It Is Unloaded and Checked. Usually They Take It Directly Into the Vessel's Hold and Stow It. Almost No Waiting Here in Spite of Great Traffic and Limited Quarters

Contrasting 60,000 two-horse wagons with 3,500 trucks it will be seen that were conditions changed so that motor trucks could be used efficiently, 56,500 vehicles would be saved. Where this touches the terminal engineer is first, in the space saved. An ordinary 5-ton truck is, roughly, 20 feet long and requires a 9-foot roadway. A 4-ton dray, with its team, is 25 feet long over all, and should have a 10-foot roadway to allow for the erratic movements of the animals. The truck occupies 180 square feet; the dray, 250. The difference is 70 square feet.

Pier rental on the west side water front of business, New York, is about 80 cents (3/4) per square foot.

Suppose that instead of adopting motor trucks for terminal trucking, assuming that it is possible to make the change, terminal facilities were so improved by the use of cranes, telphers and electric industrial trucks that horse wagons might also work to their full efficiency. Then each wagon could make three trips instead of two, totaling 15 miles—the limit of the practical endurance of the animal. It would transport 4 tons each way or 8 tons round trip, thus totaling 24 tons daily. What advantage would there be for the carrier, the steamship company?

Considerable. There would be one-fourth less vehicles to deal with, therefore less space would be occupied at any one time. Loads would be greater, and therefore fewer, for a given volume of freight, and less clerical work would be involved. But matters would not remain at this state for long, for the horse only pays when circumstances are such that he must work inefficiently. As soon as you work a horse at his highest pitch, there is a man with a motor truck who is ready to do the job better, more quickly and at less cost.

Motor trucks are little used to-day in freight-terminal work because they cannot realize their latent powers. The work is much like that for which towed barges and car ferries are used in preference to steam vessels.* Many concerns have tried to apply motor trucks to their freight shipping and receiving work, and have given it up,** and it is pretty generally accepted now among shippers that wherever else the motor truck may be able to oust the horse, it cannot compete with him in freight-terminal work.

Not until loading and unloading conditions change for the better can motor trucks be successfully operated in this class of work. Perhaps if the carriers realized the advantages which would accrue to reform of terminal methods more of an effort to change them would be made. Let us say that each motor truck occupies 70 square feet less space than a horse wagon and that each truck displaces four horse drays. Then each truck would save 280 square feet. An average downtown North River pier in New York accommodates from 200 to 300 vehicles daily. This number could be doubled under an efficient motor trucking scheme, and still congestion would be reduced 100 percent. A line with a fixed volume of business could share its pier with another similar line, thus cutting its rental in two.

Of course, much of the rental space is devoted to the storage of goods awaiting loading or carting away by teams. This space would also be less, however, because with a reduction of congestion and an increase in efficiency the goods would move more quickly. Knowing that immediate access to their consignments could be had at all times, merchants would in all likelihood make more of an effort to get them sooner, and would also not deliver goods for shipment until shortly before the vessel was ready to load.

But the carriers cannot work alone in this. They cannot force shippers and shippers' agents to employ motor trucks. They cannot require them to distribute the work more evenly through the day to avoid congestion-augmenting peak loads. They can, however, afford better physical conditions in their terminals.

It costs but 2 cents (0/1) to unload a vessel, as against from 25 to 35 cents (1/0½ to 1/5½) in some instances to subsequently handle it between the time it is raised from the hold until it is deposited at the merchant's door.

It has often been urged that the carriers adopt the system employed by the express companies, who call for and deliver shipments direct from and to the doors of shippers and receivers of goods. These companies operate motor trucks extensively and under a much higher load factor than is the case with freight-transfer vehicles. This is because the consignments of several parties are delivered together on one trip and several collections of goods made on the same return trip.

This practice is long established abroad, especially in England, where the practice has existed practically since the inception of modern freight-carrying means. In some cases separate cartage concerns are licensed by the carriers or by a number of carriers, for this work, and the method is entirely satisfactory to both carriers and their customers.

It is not altogether an untried experiment in this country. It was done by the Baltimore & Ohio Railroad in Baltimore, and was highly successful, but was discontinued because the Interstate Commerce Commission would not permit the absorption of the charges in the freight tariffs, as they are in express rates, and a separate charge was found impracticable. The New York, New Haven & Hartford Railroad employs a fleet of electric motor trucks for the transfer of freight between different terminals. In Chicago the Illinois Tunnel Company has done not only l. c. l. transfer work, but has made deliveries to large department stores, etc., as well.

In an investigation conducted by David Beecroft, William B. Stout, H. A. Tarantous and the writer in Chicago during the summer of 1912 and presented before the National Association of Automobile Manufacturers, in Detroit, November 14, 1912, the statement of J. F. Barron, freight agent of the Illinois Central Railroad, was quoted to show that it is worth while for the carriers to make motor truck use practicable:

"If motor trucks were used exclusively at six of the big railway terminals of Chicago for bringing freight to the depots and taking it away from these depots the work could be done in one-half the time at present required and at one-third the cost.

"This would mean a saving in Chicago transportation at these six depots of $4,320,000 (£886,000) per year."

Increasing freight terminal efficiency is worth while. It is possible. It will save money for all concerned. It is necessary.

* In an investigation made in New York by the author and associates in the summer of 1913 it was found that the average wait before loading at the North River inbound docks was over one hour, and that only 58 percent of the vehicles which waited in line, some as long as two hours, got onto the pier at all.

** The Loose-Wiles Biscuit Company, Long Island City, N. Y., has been using some 3 ton gasoline (petrol) trucks in freight terminal hauling, and finds that only two trips per day are possible in a nine-hour day, on an 11-mile haul from Manhattan docks. This is exactly twice the work of an ordinary horse dray, while the cost must be considerably higher. The length of haul would seem to indicate that here was a favorable opportunity for motor haulage, but the long delays at the freight wharves have made any such expectations unrealized.

NEW MAGAZINE FOR STEAMSHIP INTERESTS.—Steamship companies of New York have started a new magazine, called the *Funnel*, the object of which is to promote friendly intercourse among the steamship men of the port. Members of the management and editorial staff have been chosen from the Atlantic and coastwise companies. Edmund Dwyer is editor of the new publication.

Shipbuilding Revival in the United States

Unprecedented Demand for American-Built Ships Fills Sea Coast Yards—Over 700,000 Tons of Merchant Vessels Now Building

For the first time in many years American shipyards are filled practically to capacity with new work, with every indication that this satisfactory condition will continue for many months to come.

According to reports sent to this office from practically every shipyard in the country, there are at the present time over 200 large merchant vessels, totaling about 700,000 gross tons, under construction.

In addition to the merchant work, there are in private shipyards about 59 government vessels under construction, aggregating 168,152 tons displacement, while, in addition to that, there are also building in the government navy yards 12 vessels, aggregating 176,010 tons displacement, making a total of 71 government vessels of 344,162 tons displacement now building in the United States.

The above figures, however, do not include the tonnage of 40 submarines, 11 of which are building for foreign navies, as the particulars of submarine vessels have not been officially disclosed.

Of the merchant vessels now under construction, 116 of 643,475 gross tons are large sea-going vessels, mostly over 3,000 tons. Thirteen are over 10,000 tons each, 26 range from 7,000 to 10,000 tons, 27 from 5,000 to 7,000 tons, 10 from 4,000 to 5,000 tons, and 42 from 2,000 to 4,000 tons.

The vessels now building may be classified as follows: oil tankers, 48 of 343,851 gross tons; freighters, 53 of 228,041 gross tons; colliers, 9 of 39,855 gross tons; passenger and freight steamers, 6 of 31,728 gross tons.

Output of Shipyards in 1915

During the year 1915 the aggregate tonnage of large sea-going merchant vessels built in the United States was less than has been the case for several years. Taking into account only vessels over 100 gross tons, there were built during the year 129 sea-going merchant vessels, aggregating about 173,223 gross tons. In addition to the merchant vessels, 18 government vessels, aggregating 48,146 tons displacement were completed.

Of the sea-going merchant vessels built in 1915, 2 were over 10,000 tons; 4 were between 7,000 and 10,000 tons; 10 were between 5,000 and 7,000 tons; 2 between 4,000 and 5,000 tons and 6 between 3,000 and 4,000 tons.

Classified according to types, the output was as follows: Freighters, 19 of 62,039 gross tons; colliers, 6 of 38,410 gross tons; oil tankers, 5 of 33,238 gross tons; passenger and cargo steamers, 10 of 15,014 gross tons; and oil barges, 9 of 3,963 gross tons.

Although the figures for the output in 1915 are exceptionally low, they reflect the conditions in the American shipyards a year ago rather than at the present time. During 1914, scarcely any contracts of importance for merchant vessels were placed with American shipbuilders, and consequently deliveries of vessels in 1915 have been exceedingly few in number.

Early in 1915, however, the oil companies began to place orders for large oil tankers and these were soon followed by orders from other steamship companies for large freight-carrying steamships. With this impetus, shipyards have rapidly filled up with new work until now, in spite of the fact that almost every ship owner is in the market for new tonnage, it is practically impossible to place contracts for large merchant vessels on the sea coast for delivery inside of twenty-four months.

In this unprecedented demand for American-built ships, the oil companies have been the leaders, and at the present time approximately one-half of the tonnage of merchant vessels under construction is composed of oil tank steamships.

As shown in Tables I and II, which give the number, tonnage and horsepower of both merchant and government vessels built in 1915, and also the number, tonnage and horsepower of vessels now under construction in the leading shipyards of the United States, it will be seen that the greatest output of merchant tonnage in 1915 was from the Maryland Steel Company, Sparrows Point, Md., with the New York Shipbuilding Company, Camden, N. J., second in the list. Including government vessels, the largest total output for 1915 was from the New York Shipbuilding Company.

At the present time, the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has in hand the greatest amount of tonnage under construction, with the New York Shipbuilding Company a close second.

TABLE I.—MERCHANT CONSTRUCTION

Ships Built in 1915

	No.	Gross Tons	I. H. P.
Maryland Steel Company	6	38,956	24,900
New York Shipbuilding Company	7	29,331	13,400
Fore River Shipbuilding Corporation	2	15,000	6,000
Union Iron Works	3	11,951	5,000
Newport News Shipbuilding & Dry Dock Company	3	11,837	4,900
Great Lakes Engineering Works	10	9,603	4,894
American Car & Foundry Company	14	7,864	....
Southern Pacific Company	2	7,655	8,500
Harlan & Hollingsworth Corporation	4	7,264	11,397
American Shipbuilding Company	1	7,180	2,400
American Bridge Company	36	7,090	....
Kelly-Spear Company	3	4,862	....
Staten Island Shipbuilding Company	6	3,154	3,250
Manitowoc Shipbuilding & Dry Dock Co.	5	2,122	1,600
Baltimore Dry Docks & Shipbuilding Co.	3	1,632	650
Johnston Brothers	3	1,192	450
W. & A. Fletcher Company	1	1,080	1,500
Percy & Small	1	898	....
Anderson Steamboat Company	2	893	1,350
Toledo Shipbuilding Company	2	720	....
Dubuque Boat & Boiler Works	5	700	900
F. S. Bowker & Sons	1	567	....
Bath Iron Works	1	471	325
Wm. Cramp & Sons Ship and Engine Building Company	4	421	1,750
Charles Barnes & Co.	1	300	200
George Lawley & Sons Corporation	1	270	500
The Pusey & Jones Company	2	210	250

Merchant Vessels Now Under Construction

	No.	Gross Tons	I. H. P.
Newport News Shipbuilding & Dry Dock Company	16	120,399	43,400
New York Shipbuilding Company	22	107,639	38,070
Wm. Cramp & Sons Ship and Engine Building Company	13	71,500	46,400
Union Iron Works	10	69,240	30,800
Harlan & Hollingsworth Corporation	13	58,162	41,352
Maryland Steel Company	10	54,084	24,400
American Shipbuilding Company	12	49,100	18,000
Fore River Shipbuilding Corporation	7	49,000	21,200
Great Lakes Engineering Works	11	31,347	13,975
Toledo Shipbuilding Company	7	20,000	4,000
Baltimore Dry Docks & Shipbuilding Co.	4	14,000	7,200
American Bridge Company	35	12,223	....
Chester Shipbuilding Company	2	11,600	6,000
Seattle Construction & Dry Dock Co.	2	7,800	5,000
Kelly-Spear Company	5	3,380	....
American Car & Foundry Company	4	2,744	....
The Pusey & Jones Company	7	2,320	1,150
Staten Island Shipbuilding Company	7	1,908	4,050
G. G. Deering Company	1	1,900	....
Manitowoc Shipbuilding & Dry Dock Co.	4	1,880	1,650
Johnston Brothers	2	800	....
Percy & Small	1	800	....
Charles Barnes & Co.	2	720	400
F. S. Bowker & Sons	1	567	....
Ellicott Machine Corporation	3	540	1,950
Bath Iron Works	1	418	7,000
Anderson Steamboat Company	1	360	500
Dubuque Boat & Boiler Works	2	85	105

TABLE II.—GOVERNMENT CONSTRUCTION

Vessels Built in 1915

	No.	Tons Displacem't	I.H.P.
New York Shipbuilding Company	4	35,296	87,270
Seattle Construction & Dry Dock Co.	1	3,580	....
Wm. Cramp & Sons Ship & Engine Building Company	3	3,120	51,000
Newport News Shipbuilding & Dry Dock Company	2	1,800	2,000
Ellicott Machine Corporation	2	1,100	1,250
Fore River Shipbuilding Corporation	1	1,050	16,000
Bath Iron Works	1	1,040	15,000
Spedden Shipbuilding Company	2	620	560
Hall Bros. Marine Railway & Shipbuilding Company	2	540	800

Government Vessels Now Under Construction

	No.	Tons Displacem't	I.H.P.
New York Shipbuilding Company	5	63,450	101,500
Newport News Shipbuilding & Dry Dock Company	2	63,400	63,000
Fore River Shipbuilding Corporation	*24	30,842	77,000
Wm. Cramp & Sons Ship & Engine Building Company	3	3,290	54,000
Bath Iron Works	3	3,235	52,000
Craig Shipbuilding Company	†9	1,750	1,500
Manitowoc Shipbuilding & Dry Dock Co.	1	1,100	1,000
Seattle Construction & Dry Dock Co.	‡4	1,085	20,000
Lake Torpedo Boat Company	§8	....	....

Shipbuilding on the Atlantic Coast

The output of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., for 1915 consisted of the two Coast Guard cutters, *Ossipee* and *Tallapoosa,* of 900 tons displacement and 1,000 horsepower each, a freighter of 3,063 gross tons and 1,500 horsepower for the New York & Porto Rico Steamship Company and two freighters of 4,387 gross tons and 1,700 horsepower each for the Crowell & Thurlow Steamship Company. The battleship *Pennsylvania* was launched in 1915 and was about 93 percent complete at the end of the year. The only other government vessel that is under construction at the Newport News yard is the battleship *Mississippi.* The list of merchant vessels building, however, includes eight oil tankers, six for the Standard Oil Company and one each for the Southern Pacific Company and the Atlantic Refining Company. Four of the Standard Oil ships are of 10,900 gross tons and 3,000 horsepower each. A freighter of 8,000 gross tons is under construction for the Luckenbach Steamship Company, a freight and passenger ship of 6,000 gross tons for the Mallory Line, two freighters of 4,600 gross tons each for the Munson Line, two freighters of 5,900 gross tons each for Crowell & Thurlow Steamship Company, and two freighters of 4,500 tons each for the Southern Pacific Company.

Two destroyers and the destroyer tender *Melville* were devlivered to the United States Navy Department by the New York Shipbuilding Company, of Camden, N. J., during 1915, as well as the battleship *Moreno* for the Argentine Government. The output of merchant vessels at this yard during the year consisted of a lumber steamer of 5,483 gross tons for the Carpenter-O'Brien Company, the oil tanker *Gulfcoast* of 5,188 gross tons for the Gulf Refining Company, two colliers of 5,266 gross tons each for the Coastwise Transportation Company, two colliers of 3,289 gross tons each, one for the Harby Steamship Company and the other for the Pocahontas Navigation Company, and the dipper dredge *Cascadas,* of 1,550 gross tons, for the Isthmian Canal Commission. The machinery of all of the merchant vessels consisted of Scotch boilers and triple expansion reciprocating engines, while the government vessels were engined with either Curtis or Parsons turbines and watertube boilers of either the Babcock & Wilcox or Thornycroft types. The destroyer tender *Melville* was equipped with Parsons turbines and reduction gear.

The work now under construction at the yards of the New York Shipbuilding Company includes two destroyers and the battleships *Oklahoma* and *Idaho* for the United States Navy; four oil tankers of 10,250 gross tons each for the Standard Oil Company, an oil tanker of 10,250 gross tons for the Petroleum Transport Company; two oil tankers for the Gulf Refining Company, one of 10,250 gross tons and the other of 5,188 gross tons; two colliers for the Coastwise Transportation Company and two for the Pocahontas Navigation Company, the former being of 4,015 gross tons and 5,266 gross tons respectively, and the latter of 3,289 gross tons each. There are also three colliers, two of 5,266 gross tons and one of 8,500 gross tons, building for the Darrow-Mann Company, and eight car floats of about 750 gross tons each for the New York, New Haven & Hartford Railroad Company. Except for the naval vessels, the machinery for these ships consists of Scotch boilers and reciprocating, triple or quadruple expansion engines.

With the exception of the steam yacht *Whileaway,* of 421 gross tons, equipped with Parsons turbo-reduction gear machinery and White-Forster watertube boilers, built for Mr. Harry Payne Whitney, the whole output of the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., for the year 1915 consisted of government work, including three destroyers and three scows for the Panama Canal. This yard now has under construction five destroyers for the United States navy, and seven oil tankers, five of them being of 7,100 gross tons (two for the Sun Company, two for the Petroleum Transportation Company and one for the Petroleum Oil Company). The other two oil tankers are of 2,800 gross tons for the Mexican Navigation Company. The Cramps yard also has under construction three freighters of 6,300 gross tons each for W. R. Grace & Co.; two passenger and freight vessels of 4,400 gross tons each for the Atlantic Gulf & West Indies Steamship Company, and a car ferry of 2,700 gross tons for the Florida East Coast Railway.

The output of the yards of the Harlan & Hollingsworth Corporation, Wilmington, Del., for 1915, consisted of an oil tank steamship of 5,605 gross tons for the Shell Company of California; a twin screw ferryboat of about 1,330 gross tons for the Fort Lee Ferry Company, New York; an oil barge for the Commercial Company, and a small twin screw car ferry for the Bethlehem Steel Company. A large number of boilers were also built for installation in vessels built elsewhere. In common with the other Atlantic coast yards, the work now in hand at this plant consists largely of oil tank steamships, two of 5,605 gross tons being under construction for the Shell Company of California; three of 5,800 gross tons and one of 8,490 gross tons for the Standard Oil Company of New Jersey; one of 5,347 gross tons for the Petroleum Transport; one of 2,750 gross tons and another of 5,605 gross tons for the Vacuum Oil Company. A coastwise freight steamer of 2,010 gross tons is under construction here for the Baltimore & Carolina Steamship Company, a freight and passenger steamship of 4,500 gross tons for the Ocean Steamship Company and another of 750 gross tons for the Wilmington Steamboat Company, as well as a Diesel-engined 96-foot motor yacht for Mr. William G. Coxe, president of the Harlan & Hollingsworth Corporation.

In the marine department of the Maryland Steel Company, Sparrows Point, Md., which turned out the largest volume of merchant tonnage in 1915, the output consisted of two colliers of 10,650 gross tons for the Panama Canal, two freight steamers of 3,628 gross tons each for A. H. Bull & Co., a freighter of 6,600 gross tons for the Ameri-

* Includes twenty submarines, details of which are withheld. Ten are for Great Britain and one for Spain.

† Eight are submarines for the United States Navy, details of which are withheld.

‡ Three are submarines for the United States Navy, details of which are withheld.

§ All are submarines for the United States Navy, details of which are withheld.

can-Hawaiian Steamship Company, and a passenger and freight steamer of 3,800 gross tons for the Munson line. In addition to two oil tankers of 10,000 tons each for the Standard Oil Company, this yard now has under construction two freighters of 5,800 gross tons each for the American-Hawaiian Steamship Company, three freighters of 3,628 gross tons each, two of which are for the Munson line and the other for A. H. Bull & Co., and two freighters of 3,800 gross tons for the Bull Insular line.

The Fore River Shipbuilding Corporation, Quincy, Mass., has had under construction during the past year a large amount of government work, including four destroyers, one of which was delivered in 1915, nine submarines for the United States navy, including the fleet submarine *Schley,* one submarine for the Spanish government, and ten others for the British navy. The list of merchant vessels building at the Fore River yard includes four tank steamers of 7,500 gross tons and 3,000 horsepower each for the Texas Company, three molasses steamers of 5,000 gross tons and 2,400 horsepower each for the Cuba Distilling Company, and two cargo steamers of 9,500 gross tons and 4,000 horsepower each for the Luckenbach Company. The United States battleship *Nevada,* which is being built by this company, has already run her trials and is nearly complete.

In Baltimore, the Baltimore Dry Docks & Shipbuilding Company delivered in 1915 to the Huasteca Petroleum Company two oil barges, one of 564 gross tons and the other of 318 gross tons, and to the United States War Department a sea-going suction dredge of 750 gross tons. Four bulk oil tankers of 3,500 gross tons and 1,800 horsepower each are now under construction by this company for a Norwegian firm, the Trans-Atlantic Motor Ship Company. These vessels will each be equipped with three Bolinders engines of 600 brake horsepower each.

The Ellicott Machine Corporation of Baltimore delivered two hopper dredges, of 450 and 650 gross tons respectively, for the United States government, and now has under construction three tugs for the Pennsylvania Railroad of 180 gross tons each. The Spedden Shipbuilding Company, also of Baltimore, built the lighthouse tender *Laurel* for the United States Lighthouse Department, the sea-going dredge *Minquas* for the United States Engineers' Department, and a tug for the Maryland Dredging Company in 1915, and now has under construction a new tugboat and is installing boilers in several other vessels.

A new shipyard on the Delaware River, the Chester Shipbuilding Company, Ltd., Chester, Pa., which has taken the site of the old Roach yard, is building two cylindrical tankers for carrying oil of about 5,800 gross tons each, fitted with geared turbine engines of the Westinghouse type designed to develop about 3,000 shaft horsepower.

The output of the Staten Island Shipbuilding Company, West Brighton, N. Y., in 1915, which consisted of six vessels aggregating 3,154 gross tons, included three tugs, a type of vessel in which this company specializes. There are now building at this plant four other tugs, as well as two steel lighters and a grain elevator.

The leading shipyard on the Maine coast, the Bath Iron Works, Bath, Me., specializes in government work and in 1915 delivered to the Navy Department the very successful destroyer *Wadsworth,* equipped with Parsons turbines and reduction gear and Normand watertube boilers. Three other destroyers are now under construction at this yard, as well as a swift turbine-driven yacht 225 feet long for Mr. D. N. Rouss. In addition to its government work the Bath Iron Works also built in 1915 the torpedo-testing steamer *Emblane* for the E. W. Bliss Company.

Although progress in the development of Marine Diesel engines in the United States has been somewhat slow, nevertheless the New London Ship & Engine Company, Groton, Conn., now has under construction 70 Nlesco Diesel engines aggregating 21,780 horsepower. In addition, the Brooklyn Navy Yard is building from designs of this company two 1,600-horsepower, six-cylinder, two-cycle, single-acting Diesel engines for the fuel ship *Maumee.*

Work on the Pacific Coast

By far the largest amount of shipbuilding on the Pacific coast is in the hands of the Union Iron Works, San Francisco, Cal. This company built two freighters of about 6,000 gross tons and 2,400 horsepower each, fitted with Curtis turbines, and also launched an oil tanker of 7,445 gross tons fitted with Curtis turbines of 2,600 horsepower in 1915. These, together with an oil barge of 387 gross tons for the Union Oil Company and a motor boat, comprised the output of the yard for the year. They now have under construction six large oil tankers, two being of 8,000 gross tons and four of 7,445 gross tons each. Two of these vessels are for J. W. Van Dyke, one for the Union Oil Company, and one each for the Standard Oil Company of California, the Standard Oil Company of New Jersey and the Standard Transportation Company of Delaware. Other work now in hand includes a twin screw turbine-driven passenger and freight steamer of 9,728 gross tons for the Matson Navigation Company and a freighter of 5,900 gross tons fitted with Curtis turbines for the Hind-Rolph Company.

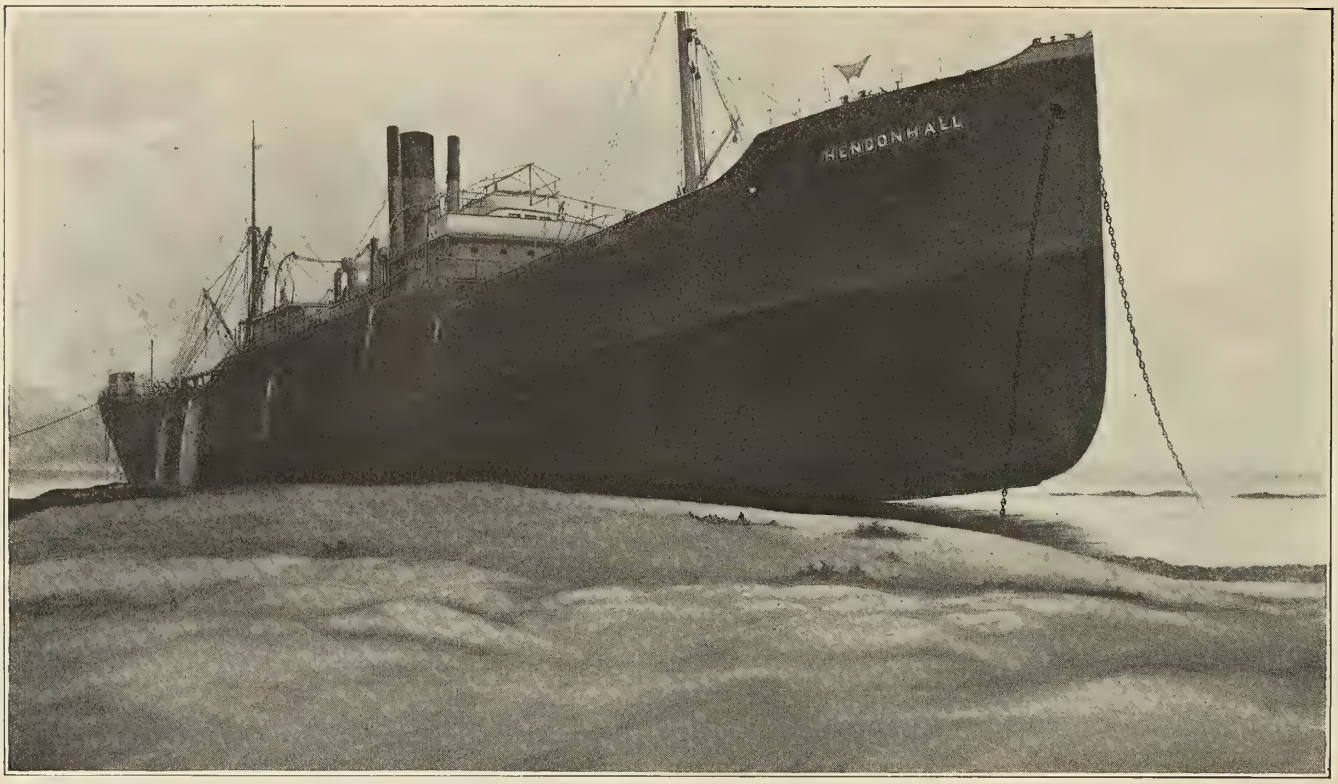
The Seattle Construction & Dry Dock Company, Seattle, Wash., completed the submarine tender *Bushnell* last year and now has under construction two freight steamers of 3,900 gross tons each for the New York & Cuba Mail Steamship Company and also three submarines and a destroyer for the United States Navy.

Hall Bros. Marine Railway & Shipbuilding Company, Winslow, Wash., built in 1915 the lighthouse tender *Fern* and the snagboat *Swinomish,* both of which have been described in recent issues of this magazine.

Shipbuilding on the Great Lakes

The American Shipbuilding Company, which operates four yards, has under construction at Lorain, Ohio, four bulk freighters of 7,000 gross tons each and one of 6,400 gross tons. Two of these vessels are for the Pittsburgh Steamship Company and one each for M. A. Hanna & Co., the Interlake Steamship Company and Herbert K. Oaks. At Cleveland the American Shipbuilding Company is building two bulk freighters of 2,100 gross tons, one for A. H. Skangaards and the other for Arthur Mathiesen. At Detroit, Mich., this company is building four bulk freighters of 2,100 gross tons each, two of them being for A. O. Lindvig, one for the George Hall Coal Company and one for Erling Lund. Another vessel of 2,100 gross tons is being built at Chicago for Erling Lund. The only vessel built by the American Shipbuilding Company in 1915 was the self-unloading bulk freighter, *W. F. White,* of 7,180 gross tons, for the Limestone Transportation Company.

The Great Lakes Engineering Works, Detroit, Mich., delivered ten vessels aggregating 9,603 gross tons in 1915 and now has under construction eleven vessels of 31,347 gross tons. The output in 1915 included three general cargo steamers of 1,414 gross tons each for the Clyde Steamship Company, two bulk freighters, a tug and several scows. The work now in hand includes a bulk freighter of 7,800 gross tons, a self-unloading freighter of 4,810 gross tons, three smaller bulk freighters, a wrecking steamer, two colliers and two cargo steamers of 2,500 gross tons each.



At Low Water the Bow of the *Hendonhall* Was High and Dry

The Refloating of the Hendonhall

Compressed Air Again Saves Another "Hopeless Wreck"— Vessel Kept Afloat Practically Without A Bottom

BY ROBERT G. SKERRETT

Modern methods, plus expertness and experience, have saved another "hopeless wreck"—this time the steamship *Hendonhall,* a ship of 4,000 tons gross, which went ashore while bound into the St. Lawrence from Cardiff, November, a year ago. For the better part of nine months the vessel lay on the rocks between Trinity Bay and Point des Monts. Storm after storm added to the gravity of her situation, as well as to the extent of her injuries. Her position was an exposed one and there seemed only the scantiest grounds for hoping for her release.

Various methods for her refloating were proposed, among them that of jacking her clear of the ragged ledge and then building launching ways under her. All of these schemes involved prohibitive outlays, considered in the light of the boat's current value. About the middle of July of the present year the Canadian Salvage Association, licensee of the Yankee Salvage Association, of New York City, took on the job of getting the ship free so she could be towed to Quebec. Mr. W. W. Wotherspoon, the well-known wrecking expert, was in charge of the operations, and on August 26 the *Hendonhall* was refloated.

Perhaps the most interesting feature of this salvage undertaking was that the damaged craft, in order to get her clear of the rocks, was floated at practically her "builders' light draft;" that is, the vessel was floated at the draft she would have had normally without coal aboard or water in either the boilers or double bottom. Manifestly, this meant giving the ship, and a badly damaged one at that, an exceptionally large measure of buoyancy, and this without recourse to extraneous means in the way of pontoons, etc.

The *Hendonhall* went ashore at high tide. At low water her bow was high and dry, although her stern still floated free. She was filled with water fore and aft, including the engine room. The bottom under No. 2 hold was crushed and opened so badly that the sea, during storms, broke inside of the vessel well nigh as freely as outside. The whole tank was ripped open, and the rent was even much larger than in the case of the *Royal George,* which the same company successfully floated two years ago. The task was made harder, inasmuch as it was decided to use compressed air, because the *Hendonhall* had no 'tween-decks, and special facilities were resorted to in order to strengthen the decks above and to deal with the very large cargo hatches on that deck.

The first thing done was to pump out the engine rooms, for otherwise nothing could be done. This work was successfully executed, and the tank tops were repaired there and in the other holds, except in No. 2. This latter compartment was 80 feet long, 48 feet in beam and 27 feet deep. The crux of the operation was to get the water out of this hold. Before this was done the vessel was lightened by removing 500 tons of bunker coal. After the deck was braced compressed air was pumped into the hold at a pressure of six pounds to the square inch. Oil-driven air compressors were used for that purpose and for the first time in Canada. The independent nature of this type of compressor makes it ideal for such service. It may be

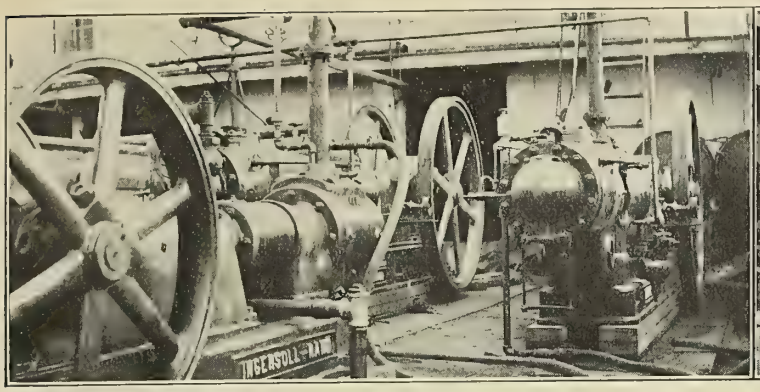


Fig. 2.—Air Compressors Mounted on Deck

Fig. 3.—Patches on Injured Tank Top

easily mounted directly upon a wreck if there is a small area of level surface available, and it may be run continuously, irrespective of steam or any other power; it burns practically any of the cheap fuel oils, as kerosene (paraffin), distillate, naphtha or crude oil. One of these

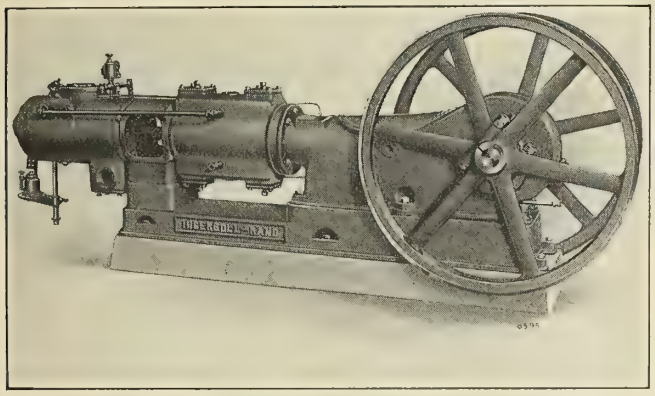


Fig. 4.—Ingersoll-Rand Oil-Driven Air Compressor

oil-driven machines was run continuously 24 hours a day, 300 revolutions per minute, without stop or breakdown, for three weeks and one day, starting at 9 A. M. on August 22. The severity of such a test was accentuated by the fact that, although designed for delivering air pressures from 70 to 100 pounds, this compressor was operated at a totally different air-discharge pressure, namely, 4 pounds per square inch.

The oil-engine compressors are known as "Ingersoll-Rogler" Class 'ERO.'" The engine and compressor are mounted on a common base and connected directly on the "straight-line" principle, having a common stroke of 10 inches. The compressor cylinder is double acting, 10 inches in diameter. The oil-engine cylinder is 12½ inches in diameter and operates on the "two-cycle" principle. The rated piston displacement of the air cylinder is 261 cubic feet per minute, and the fuel consumption operating at 100 pounds air-pressure averages 3½ gallons per hour, based on fuel having a thermal value of 20,000 British thermal units per pound. At the low-pressure at which these compressors were run, the fuel consumption was considerably less than this figure.

The ticklish part of the undertaking lay in nicely adjusting the vessel's draft, because she was so caught under hold No. 2 that only a few inches of leeway was allowed in regulating her trim. It was necessary that she should not draw more than 6 feet 9 inches forward and 14 feet aft, lest any acuter angle increase the grip of the rocks even at high tide. Thanks to the skillful manner in which she was handled, the *Hendonhall* was freed about an hour and a half before high water on a moderate spring tide. At the time of her release her engine room was purposely partly flooded and a quantity of water was carried in No. 4 hold, not only to assist her trim by the stern, but to list her in order to facilitate her clearance.

The ship was kept afloat practically without a bottom, and was taken up the St. Lawrence River to Quebec, a distance of about 250 miles.

Fig. 5.—Bow View

Fig. 6.—Position of the Steamer on the Rocks at High Water

Although the Construction of Sailing Vessels has Steadily Declined in Recent Years, Nevertheless the Above Photographs Taken Recently Outside of Sandy Hook Show That Employment is being Found At the Present Time for the Existing Fleet of "Windjammers"

Modern Submarines in War and Peace—VII

Under-Ice Navigation with a Submarine—Experiments and Tests with the Protector in 1903

BY SIMON LAKE

All navigators know the difficulty of attempting to break their way through ice fields, since it requires a vessel of tremendous power and great weight to break down, or through, solid ice. Fig. 51 illustrates a vessel designed by the author in 1903 for navigation in ice-covered waters. A vessel of this type was first proposed by the author in 1899 for exploration purposes in ice-covered seas. In 1903, experiments were made with the *Protector* in order to demonstrate the practibility of navigating in ice-covered waters.

Professor Nansen, in his North Polar explorations, has stated in his book that his average rate of progress during eighteen months, in attempting to reach the North Pole, was only three-quarters of a mile per day, and that the thickest ice he found during these months of endeavor was 14 feet. His progress was delayed by open waters, slush ice, and in the winter by the intense cold, which compelled him to "hibernate" for a considerable period of time.

An under-ice submarine as illustrated, with large storage battery capacity, could navigate underneath the ice in perfect comfort and safety. The temperature surrounding the vessel, even in the most severe winter weather, would not exceed the temperature of the sea water. The vessel above illustrated is designed to make a continuous submerged voyage of 150 miles on one charge of the storage battery. After such a run, it would be necessary to stop and recharge the batteries. If open water should be encountered, this recharging process would be done by bringing the vessel to the surface. If the ice was not too thick, then by blowing out the water ballast the ice would be broken, since it is very much easier to life the ice and break it, rather than to force it apart or downward, as surface vessels are compelled to do.

Provision is made for boring a hole up through the ice so as to permit the drawing in of sufficient air to run the engines and to recharge the batteries. Provision has also been made for putting out small mines underneath the ice to blow an opening to permit the submarine to come to the surface. A telescopic conning tower arranged to cut its way up through ice 12 or 14 feet thick is also provided to enable the boat to remain under the ice and still permit the crew to reach the surface.

In navigating in an ice-pack, the method of procedure would be to reduce the buoyancy of the vessel to, perhaps, a couple of tons, and then steam ahead, and it will be observed that the forward portion of the boat extends downward a considerable distance under the water, so that when the forward portion of the boat contacts with heavy ice the reserve buoyancy will not be sufficient to lift or push the ice out of the way, and the vessel will then be automatically pushed under the ice and run along in contact with the under surface of the ice. A toothed recording wheel would give the exact distance traveled, and of course the compass will give the direction. Progress could be made in perfect comfort and safety under the ice at a rate exceeding 100 miles per day.

Fig. 51 shows the vessel fitted with torpedo tubes, and an athwartship propeller in the stern for training the vessel, and also with bottom wheels to permit navigation on the water bed. This combination would permit vessels of this type to enter ice-bound ports or harbors and destroy the enemies' shipping while the same lies "frozen in" and helpless.

The *Protector*, which was fitted out in 1903 for experi-

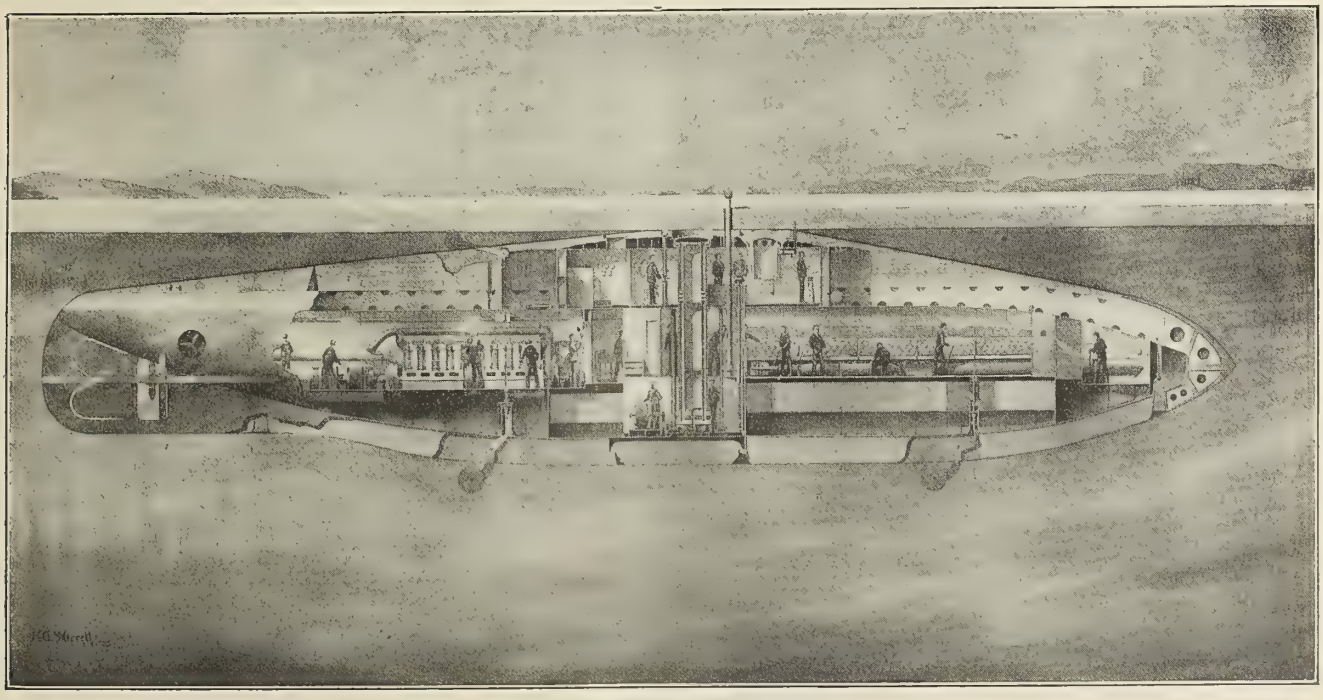


Fig. 51.—Under-Ice Navigation

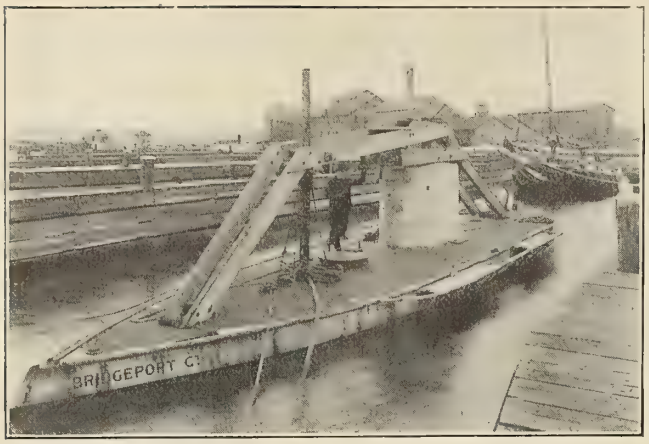


Fig. 52.—The *Protector* Fitted in 1903 for Experimental Navigation Under the Ice

mental navigation under the ice, is shown in Fig. 52 with an inverted toboggan built up over the conning tower. This arrangement enabled her to readily navigate under ice fields. The view of the *Protector* shown in Fig. 54 was taken before she was fitted with the experimental inverted toboggan, and shows the vessel emerging through an ice field in Narragansett Bay. This ice field was about 8 inches thick, and she readily broke her way up through same. The United States Army Board, General Arthur Murray, and Captains Bailey and Parker are shown on top of the conning tower.

Ice two feet in thickness is sufficient to close navigation to the most powerful of ordinary surface ships, and great power is required to crush or break a lane through it by the specially equipped ice breakers now used in northern latitudes.

While ice is a deterrent to surface navigation, it is actually an aid to under water navigation, providing the submarine boat is specially equipped with guide wheels or "runners" on top of the hull to enable her to "slide" or "wheel" along under the ice.

The principal feature of the design of under-ice submarine illustrated was prepared by the author a number of years ago to meet the desires of an associate of Captain Nansen, the Arctic explorer, for a vessel that could be navigated either on the surface or under the ice. I

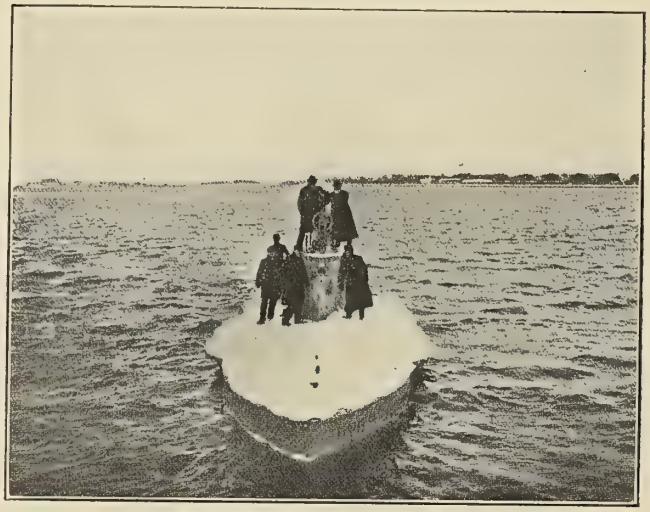


Fig. 54.—The *Protector* Returning to Fort Adams with Army Board on January 20, 1904. Deck Covered with Ice

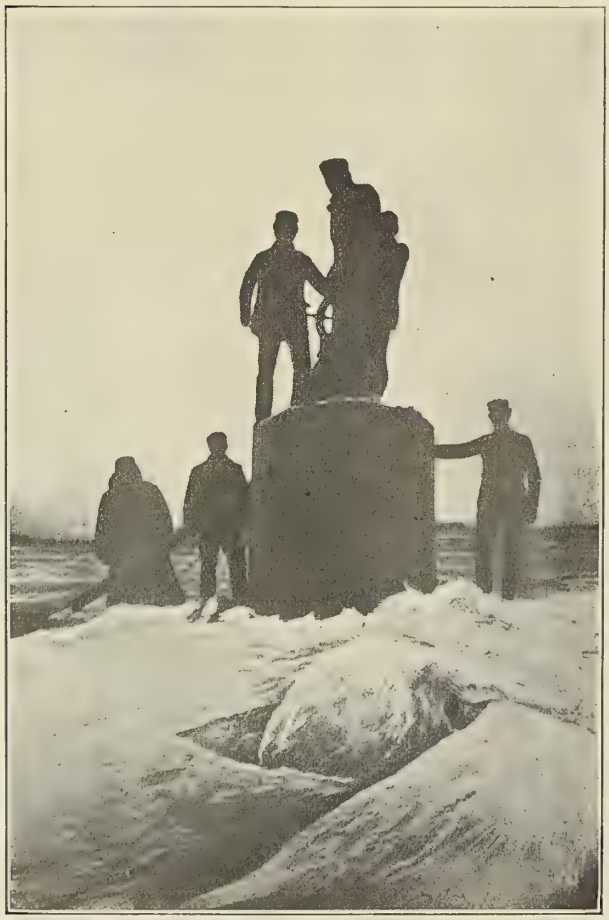


Fig. 53.—The *Protector*, After a 3-Hour Submerged Run, Emerging Through a Heavy Ice Floe. Members of an Army Board on Top of the Conning Tower

explained the principal features and possibilities of a vessel of this type for under-ice navigation before the faculty of Johns Hopkins University, in Baltimore in 1898, and at one time I thought one of the prominent New York daily newspapers was going to finance the building of such a vessel for North Polar exploration work, but the submarine was then looked upon as too much of an experiment and nothing ever came of the negotiations.

Some years afterward, in Christiania, Norway, I met and discussed the project with Captain Scott Hanson, R. N., who was associated with Nansen in his historical search for the North Pole, and he became quite enthusiastic over the possibilities of a submarine of this type for North Polar exploration.

An under-ice submarine of the type illustrated, fitted with large storage battery capacity, would be able to average one hundred miles per day under the ice, and about two hundred and fifty miles per day in open water. Starting from Spitzbergen, therefore, and going over Nansen's route, if the same conditions were met as he describes, the round trip to the Pole should be made in about ten days' time, and in perfect comfort, as no matter how cold the weather is above the surface, the temperature of the water surrounding the submarine is always above the freezing point.

Later I was asked to submit to the chief engineer of one of the Canadian railways plans for an under-ice cargo-carrying submarine to enable them to transport passengers, mail and freight from their main land terminal at Vancouver to an open harbor on the island of Victoria.

(To be continued.)

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

A Marine Engineer's Kit of Tools

My boy graduated from a technical school the early part of last summer. Since then he has been working in an office where he could wear nice clean cuffs and a stiff collar, but he came home a couple of weeks ago and told me he had "tendered his resignation" (we used to call it "quitting the job"), and that he was going to sea as an oiler on one of the M. & N. boats.

I am a machinist by trade, and therefore know what a good kit of tools means, so to start my boy right I shall fit him out with the following articles:

Center punch.
4 and 6-inch in- and outside calipers.
4 and 6-inch hermaphrodite calipers.
4 and 6-inch dividers.
6-inch hardened try square with beam.
6-inch hardened try square flat.
Thread gage.
2, 4 and 6-inch steel scales, divided in tenths and eighths.
Center gage for lathe work.
20 feet of No. 20 piano wire, with anchor and turnbuckle.
20-foot chalk line and piece of chalk.
Soapstone pencil.
Plumb-bob and level.
Small hand drill with chuck.
A dozen small twist drills, ⅛ and smaller.
Lot of short pieces of drill rods to match drills.
1-inch micrometer.
9-inch scriber.
Depth gage.
Bottle of copper solution.
Bottle of collodion.
Adhesive tape, court plaster, small pair of scissors, safety pins, needles, threads and buttons.
Sheet of crocus and emory cloth.
Small oil stones.
Small oil can.
Mirror, 2 by 4 inches.

A friend, who is also a machinist, dropped in to see me, and I showed him the list and asked him what he thought of it. He read it over and said: "I have never been to sea, but I should think that if you give the boy a center punch, a hammer would come in handy."

There, Mr. Editor, I had overlooked one of the most important things in the whole kit. So I am going to ask your readers to look over this list, if you think it is worth while publishing it, and say through your columns whether I have got too much or too little in the way of an outfit for the boy.

I have my doubts about a level or a plumb-bob being of any use at sea, but naval engineers ought to know.

I have always found a small mirror very handy to throw light into dark corners, also for looking at the under side of something where you couldn't stick your head. The tool chest in which I am going to put all these things will have a flat top and it will be made of nice, well-seasoned white pine, so that it can be used as a drawing board. And, of course, it will be nicely squared up, and I will put some thumb tacks, a small T square and a forty-five and sixty-degree triangle in the kit.

The anchor and turnbuckle, or stretcher, has to be home-made, as I do not find them in the market. The anchor is a piece of round drill rod, ½ inch diameter and ½ inch long, drilled for the wire and provided with a set screw to hold it. The turnbuckle can be made to suit anybody's fancy.

For the copper solution to overcome the trouble with greasy surfaces the following recipe will be found very satisfactory. To a half ounce of blue vitrol dissolve in four ounces of water, add slowly, drop by drop, a teaspoonful of sulphuric acid.

THE BOY'S FATHER.

Repairs to a Defective Tube

Cleaning a boiler isn't a very pleasant task, but it's a very gratifying piece of work, for it gives one a lot of satisfaction to know the actual conditions both inside and out. The engineer who neglects cleaning the boilers sooner or later suffers from the neglect, and the following incident is one of the few examples of this.

I might say that this particular engineer was in the habit of cleaning the boiler every week when possible, but, due to work out of our regular schedule, we didn't get an opportunity to clean until it was too late.

This boiler was a Mosher watertube boiler and very satisfactory in every way. But the rest of the installation was very inefficient. A steam jet was used for forced draft, and, of course, necessitated considerable make-up feed water to be supplied. Water coolers were used on the bearings constantly, the water draining into the bilge and put overboard by a steam injector, another large user of steam and make-up feed water. Boiler injectors were used quite frequently, besides a deck winch exhausting into the atmosphere. Roughly, I would say that about 30 percent of the feed water had to be taken direct from the sea cock. It is this fact and the circumstance that we were running in and out of muddy rivers that made it so necessary to clean often.

As before stated, we didn't get an opportunity to clean on this occasion, and, with the other boiler in a bad condition, we left Milwaukee for Detroit. When north of the Manitou Islands the fireman noticed one of the tubes near the front getting rather light in color. The engineer was called, and it was evident to him that the tube was getting no circulation. The fireman was ordered to put ashes on the fire under the tube and thus relieve the heat in it. But this did no good, for in a few minutes it burnt and blew through, although not badly, because of the baked mud and scale in the tube. As we did not lose water very fast, we steamed ahead slowly as far as St. Ignace, where we pulled fires and blew the boiler down and cleaned thoroughly.

The Mosher Company used to furnish plugs to use in such a case, but we had neither plugs nor spare tubes, so it was necessary to make plugs for the occasion. These plugs were fitted and the boiler fired. The plugs, such as they were, didn't fit very well and the leak was still too great to proceed further.

The engineer had a tube expander among his personal possessions, and he went about fixing it in the following manner:

About 10 inches of the tube at each end was still in good condition, so we cut out the tube, cut off the good ends into two neat lengths of about 8 inches each. We then headed an end of each tube and hammered it closed and welded. These were then inserted in the manifolds and rolled from the furnace side, forming what the engineer called a "dummy."

Steam pressure being on the outside of the "dummies" tended to keep the blind end closed, and when pressure was again raised no leak was perceptible. I believe these "dummies" have never since been replaced by a new tube.

N.

The Preservation of Marine Boilers

To the seagoing engineer the condition of the boilers under his charge is a constant source of anxiety, and justly so, for on them all other parts are directly dependent. As a consequence there is no work in the engineers' department which will count to greater advantage than constant and intelligent care in fighting the forces of deterioration, either mechanical or chemical, or both, which commences immediately after the boiler is lowered into the hold of the vessel.

Of the two forms of corrosion, internal and external, the latter is the one the great percentage of boilers suffer from the most, and, in fact, if they could be kept perfectly tight, so that there was no leakage at rivets, seams or tubes, internal corrosion, except in rare instances, would cause but little trouble and the life of the boiler would be doubled and trebled. However, as the perfect boiler is yet to be built, the best that can be done is to check all leaks as soon and as effectively as possible.

Unfortunately, the exigencies of marine service in many cases are such that the boilers are kept under steam for many days continuously, thereby preventing repairs which should be made at once, and as a result when the opportunnty does come the fault has become greatly aggravated, requiring much greater skill and labor to make it good, if, indeed, it can be successfully repaired at all.

In placing boilers in the ship, care should be taken that the saddles do not come in line with the circumferential seams, as these latter at the bottom of the shell are very liable to leak. A longitudinal seam at the bottom of the shell is very liable to be a constant source of trouble.

The most common sources of external corrosion are exposure to leakage from joints, tubes or fittings, dripping from mountings, moisture rising from the bilge and sweating. Serious sources of corrosion of the heating surfaces result from neglect to thoroughly clean furnaces, tubes and connections of ashes and soot before they have had an opportunity to absorb moisture, which they will do shortly after they become cold. Ashes collecting in cracks and joints between bridge walls and furnaces after fires are hauled soon absorb moisture and rapid corrosion of furnace plates is the result. Wet ashes by the front of the boiler are especially destructive. In cleaning furnaces a half a dozen bars taken from each will allow the ashes to be thoroughly removed from the bearers and bridge walls.

Leaky seams and rivets should be calked at the earliest opportunity; in some cases in old boilers where the seam is beyond calking and is on or near the shell bottom the application of a dose of cement will often greatly check or stop it. Take about equal parts of Portland cement and fresh, sharp sand, mixing with fresh water to the consistency of mortar and apply to the faulty seam from the inside of the boiler. Wherever the cement is to be applied the metal should first be thoroughly cleaned with lye to remove any grease or sediment.

If leaky tubes are not attended to at once a thin layer of rust will form between the tube and sheet, rendering it a difficult matter to make the tube tight ever after. If the tubes become thin and weak from rapid expanding the only remedy left is, after a final expanding, to fit ferrules, driving them in solidly. The writer's experience with cast iron ferrules has not been altogether satisfactory. Some of the tubes in a Scotch boiler in the ship on which he last served were fitted with cast iron ferrules, but the tubes remained tight only a short time and it finally became necessary to remove these ferrules and substitute others of wrought iron, after which no further leaking occurred.

The one effective method of checking leakage around screw stays with riveted heads is by upsetting; that is, with a heavy sledge held firmly against one head, several sharp blows with a quarter hammer on the leading head will fill out its threads into those of the sheet, making it perfectly tight. Calking the heads is a little worse than useless. Internal calking is an evil, from the fact that it is often the cause of serious grooving of the plates. It is never necessary in a well-made boiler.

Considering the question of corrosion chemically, we find that dry, pure oxygen alone has no action on iron or steel; moist oxygen acts only very slowly, and pure, dry carbonic acid has no action. But when these gases are mixed in the presence of moisture, as in the hold of a vessel, rust or corrosion rapidly follows and goes on at an increasing rate. To abate this evil all possible means should be taken to drive out of the boiler compartments as much of the moisture as possible. When the weather is dry much benefit may be derived from running one of the blowers moderately in each compartment if the boilers are not to be used for some time; an auxiliary steam pipe might be tapped, and a line of pipe led into the lower manhole of each boiler, the boiler otherwise being closed so as to retain the heat, the pipe thence leading to the trap. This method the author used on the boiler of one of our coastwise steamers with excellent results. The interior of the boiler remained dry and there was no external sweating, excepting from a foot or two from the back head beyond the heater pipe. With this method care should be taken that there is sufficient pipe to not only raise the temperature of the air inside the boiler, but also to raise that of the shell slightly above the surrounding external air, otherwise sweating of the shell will go on inside as well as outside.

An excellent method of checking internal corrosion is the introduction of a barrel or two of quicklime into the empty boiler and then closing all plates, the lime absorbing the moisture and effectually checking the corrosion.

Of the different forms of internal corrosion, pitting or honeycombing is the most serious, and it first made its worst attacks in marine boilers at the time of the introduction of the surface condenser. Of this form of corrosion it has been truly said that the only characteristic that was uniform in relation to it was the want of uniformity with which it occurred. It is certainly most capricious in its attacks, be it in the same boiler or in a battery working under exactly similar circumstances. It may be found on every plate or on only one plate of a boiler, generally below the water level, although at times above it. The braces are sometimes the only part affected, while again these latter are free and the plates are seriously attacked. In a half dozen boilers made of the same brand of plates, in the same shop and then worked side by side, one boiler will be seriously affected by pitting, the remainder suffer-

ing very little, if at all. Unlike ordinary corrosion, pitting is marked by sharply defined edges, resulting in holes and patches of from one-quarter inch to six inches or more in diameter, and often assuming very irregular shapes, the depth of the pitting varying from one-thirty-second to one-quarter inch or more.

Sometimes this form of corrosion acts in a somewhat different manner, the plates becoming indented by very small holes close together, somewhat resembling in appearance the wood sheathing of a ship which has suffered from the effects of teredo. Perhaps the most satisfactory method of dealing with this form of corrosion, termed honeycombing, is the application of cement. Where it is applied to heating surfaces the following method has been used with very satisfactory results: First, thoroughly clean the surface affected, mix Portland cement with fresh water, without sand, to about the consistency of ordinary whitewash, and apply two coats with a whitewash brush. It will seldom be necessary to repeat the dose unless the boiler has been subjected to sudden changes of temperature, when it will be well to examine it carefully to see that the cement is not cracked. There have been many theories advanced as to the cause of this pitting action, among the more plausible of which are:

Galvanic action, caused by particles of copper or brass from the condenser tubes, air pumps and feed pipes carried in with the feed water, which latter being acidulated, the more likely alkaline becomes the exciting agent. However, inasmuch as these particles of copper or brass would by their weight gravitate to the bottom of the boiler, or lodge on the tops of tubes or furnaces, here is where we should expect to find the greatest corrosion or pitting, which, unfortunately for this theory, is not by any means the case. There is undoubtedly a very material wearing away of copper and brass pipes, due to the mechanical action of water and steam, aided possibly by any oily acid which may be present.

Hydrochloric acid, produced within the boiler by the decomposition of the water, its hydrogen combining with the chlorides contained in the sea water, is by some regarded as the cause. If such were the case the water would become strongly acidulated, and if it obtained sufficient strength to produce pitting it would have a decided solvent action on zinc placed therein; moreover, numerous analyses made of water from boilers in which this pitting action has gone on seriously have always shown it to give an alkaline reaction.

Decomposition of cylinder lubricants is pointed out as another cause. The resulting fatty acids dissolve the brass of the condenser tubes and pass into the boiler and convert water into a solution of copper, which acts electrochemically on the water and iron, thereby causing corrosion or pitting. This action, however, would cause a wear on the condenser tubes proportional to that of the boiler iron; moreover, pitting is found to occur just as much when the condenser tubes are tinned. Again, as stated above, the water from marine boilers, except in very rare cases, is found to be distinctly alkaline; also analyses of the water show not the slightest trace of copper in solution.

Presence of free oxygen is the basis of still another theory, it being thought that the presence of free oxygen in the boiler derived from the feed water would rapidly attack the iron. This theory may be partially true, in so far as affects uniform corrosion, but that free oxygen could be, by itself, the cause of pitting seems extremely improbable. On joining the last ship on which the author served he found that the vapor escape pipe from the filter had been closed. The filter was a cast iron box with closed top, having a connection with the air-pump discharge, and also fitted with connections to a weighted outboard valve. The feed pumps, being above the filter, we kept the latter closed in order to create a pressure to force the water to the feed pumps. As a consequence, much air was forced into the boiler along with the feed water, and much oil also kept it company. Now, although this boiler had been fed with oil and air in allopathic doses, a very careful personal inspection from above and below showed not the slightest trace of pitting or of undue corrosion.

The real cause of pitting in boilers, although now largely checked, has never been satisfactorily explained. Undoubtedly this peculiar destructive form of corrosion is due to no single cause, but rather to a combination of causes, which has yet to be discovered. It has been checked much the same as a doctor might check a disease of which he was unable to make a diagnosis by administering all the different combinations of medicines he could think of as bearing on the case.

The following are some of the precautions used to prevent pitting: Carefully pickling the boiler plates to remove all mill scale or oxide. Fitting large quantities of zinc in the boiler. Preventing the entrance of atmospheric air. Using only the highest grades of mineral oils in the cylinders, and little of that. Filtering the feed water to prevent the entrance of oil or other foreign substances. Tinning the condenser tubes. Using only pure water. Changing the water in the boiler occasionally. Use of sodic carbonate and sometimes of other salts.

With these combinations, in whole or in part, pitting has been largely, if not wholly, checked.

Although the weight of opinion in regard to fitting boiler zincs is in favor of close metallic contact, yet experiments which have been tried go to show that zinc simply suspended in the water of the boiler gives equally efficient results. The analyses of many samples of boiler water have shown zinc in solution, and it is a question whether the prevention of corrosion is not principally due to zinc in solution rendering the water non-exciting.

The quantity and the disposition of the zincs fitted in a boiler depends somewhat upon various conditions, such as the age of the boiler, the way it shows in tendency to undue corrosion, the kind and amount of service and the kind of water used. Rolled zinc, being purer, should always be used when possible, in preference to cast zinc. The length of time zincs will remain effective depends upon the amount of steaming and the condition of the boiler. A careful record of zinc consumption in boilers supplying engines of 1,000 indicated horsepower showed 10 pounds to 12 pounds of rolled zinc per 24 steaming hours when boilers were new. Afterwards, when in good condition, free from undue corrosion, about 5 pounds per 24 hours of steaming.

Zincs, to be effective, should not be placed over six feet apart, it having been ascertained by a series of experiments that they exerted their influence in checking pitting over only a radius of 3 feet. Zincs are of little or no use in the steam space, except when the boiler is out of use and kept full of water as a means of preservation, and in which case this portion of the boiler should contain from one-fifth to one-sixth the whole number.

Zincs deteriorate either gradually by the wasting away or by a gradual change of substance, the latter being the much more common process. They become of a dark gray or black color, brittle and more or less friable, presenting a warped, cracked or honeycombed appearance, with apparently little of a metallic nature left in their composition. Even if placed in a crucible and heated to redness, this resulting substance does not melt.

In raising steam in the ordinary Scotch boiler, plenty of time should be taken, in order to prevent severe strains

resulting from expansion. Where no means are taken to start the circulation of the large amount of water over the furnaces it is no uncommon occurrence, even though four or five hours are consumed, to have steam on the boiler while the bottom of the shell is still cold. In such a case the difference in length of the top and the bottom of the shell would amount to approximately a quarter of an inch in an 18-foot boiler, producing severe strains, and as a natural consequence continual leakage along the bottom shell seams.

As an illustration of the evil results of sudden changes in boiler temperatures, the following fact is quite to the point: It was in the winter season and the vessel was at anchor off the Massachusetts coast. One night about 2 A. M. a flange gasket near the bottom of the boiler blew out. Fires were immediately hauled and the boiler blown down, a new gasket fitted, water run up, fires lighted and the ship ready to get under way at daylight. A day or so later the vessel arrived in New York. The boiler maker's bill for calking leaky joints was about $75 (15/12/6), and the mischief did not end here, as the tubes and seams soon leaked badly again, and were only checked after additional expense for fitting ferrules to tubes and cementing seams. It is perhaps superfluous to add that this event took place in the interim between the vacation of the ship by the chief engineer and the arrival of the new chief.

In vessels where there is no auxiliary boiler and the boiler water level is below the sea level, it is a good plan to pump up to, say, a little over one-half a glass, two or three times before steam forms, to open the bottom blow and allow the water to fall an inch or two, thereby bringing the warmer water down to the bottom of the shell. Before the introduction of the hydrokineter it was a common practice to run a steam pipe into the bottom shell of the boiler to start in live steam from the auxiliary boiler shortly before lighting fires.

Another and excellent method of effecting circulation is by means of an auxiliary feed pump, having a branch suction to the bottom blow pipe, by which means the water is drawn from the bottom of the boiler and forced in near the water level.

Boilers should always be fitted with internal feed pipes, preferably leading upwards toward the water level, thus not only giving the boiler better circulation, but preventing the emptying of the boiler in case of accident to the feed valve. This also prevents corrosion of the boiler shell, which often occurs where no internal pipe is fitted, or if fitted is so led as to project the feed water against the shell plate.

Dampers should be fitted in each uptake so that when cleaning or banking fires the draft can be checked, avoiding the strong rush of air on the highly heated crowns and tube sheets. The author can speak from solid experience in this matter and can vouch for the usefulness of this appendage in avoiding leaks in furnaces, back connections and tube sheets.

An injector in each fire room is very useful, preventing the necessity of ever forcing cold water into boilers. It should be provided with a swing check in delivery pipe, close to its entrance to auxiliary feed pipe, or check valve, as the case may be. It is preferable for the injector to discharge into the auxiliary feed, for the reason that if it is desired to work the feed pump and injector at the same time, the pulsations in the feed pipe from the pump are apt to break the flow from the injector. If the latter is placed low in the ship it will sometimes refuse to work, especially with low steam, from its becoming flooded from the head of water. This can readily be obviated, however, by adjusting or partially closing the supply valve fitted in the suction pipe.

Before getting under way, it is a good plan to draw out any water which may have collected in the condenser, for, even if it has not acted slightly on the brass or copper, it sometimes contains more or less oil.

As soon as the boilers are empty they should be scaled if necessary, thoroughly washed out with a steam hose, and then carefully drained. Care should be taken to remove any loose scale, as it forms excellent little pockets or reservoirs for holding moisture. This frequently happens around the tubes or braces. Heating surfaces of boilers using forced draft should receive extra care and attention as to their cleanliness.

It should be remembered that boilers aboard ships in commission deteriorate more rapidly when out of use than when under steam, and consequently this is the time they should receive the engineer's greatest attention. All steam or water connections should be kept carefully closed on the boilers out of use to prevent the entrance of moisture from such sources. Water condensed in the escape pipe will sometimes find its way to the safety-valve seat, and when the valve is lifted, as it should be occasionally, it passes into the boiler. To prevent this, drain pipes should be fitted close to the valve below its seat.

After the furnaces, connections, ash pits and uptakes have been cleaned and any necessary repairs have been made, the boiler should be closed, leaving off only the lower manhole. Fires should be lighted in portable sheet iron furnaces or trays and placed in the ashpit of each furnace, the uptake damper being partially hauled so as to retain the heat. These fires should be lighted frequently, say three times a week, as long as the boiler is out of use. Each time after finishing with these trays place them, with the smouldering coal, in the lower manhole and loosely secure the plate in position until they are needed again. The coke will absorb much oxygen and so tend to check internal corrosion.

Another method is to pump the boiler quite full of salt water, adding about 50 pounds of sodic carbonate per 100 cubic feet of space in the boiler, the right amount of carbonate being readily determined by placing a bright piece of iron in a sample of the boiler water. If the iron rusts after several hours of immersion, add more carbonate. Before closing the boiler the zincs should be in good condition and additional ones fitted above the water line. Light fires should then be started to heat the water sufficiently to drive off entrained air. This latter method cannot well be applied to boilers of ships in commission on account of the many disadvantages. Another method which has sometimes been adopted in boilers out of commission, and with very good results, is that of giving them inside and outside two or three coats of boiled linseed oil.

As stated above, all exposed portions of the boiler should receive a good coat of paint before they become thoroughly cold, or, at any rate, before they begin to show any signs of sweating; otherwise as soon as steam is raised the paint will blister, crack and peel off.

Never use whitewash on any portion of the boiler, as it greatly promotes corrosion unless it is put on over a very heavy coat of paint. At best, it presents a slovenly appearance and requires constant renewal. Moreover, as the painting should be renewed occasionally, it becomes necessary to thoroughly clean off the whitewash—a tedious, dirty job.

Boilers of ships spending much time in the tropics are comparatively short-lived, due to excessive corrosion from the warm, moist air, and when so stationed extreme exertions should be made to protect them as much as possible.

Finally, at all times work the boilers as *regularly, evenly* and as *easily* as the service permits.

Brooklyn, N. Y. Thomas J. Rogers.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Self-Trimming Vessels

Q.—Will you kindly describe the arrangement of a self-trimmer and give some sketches? N. A.

A.—By a "self-trimmer" is commonly meant a vessel which is so arranged structurally that when carrying loose bulk cargoes the cargo will flow into the holds with little, if any, trimming by hand being required to ensure the cargo completely filling the holds. The commonest forms are those which are so built that they have a central trunk or feeder which, when filled, ensures that the cargo, by nature of its fluidity, will eventually reach all parts of the holds. Cargoes such as grain or coal are those most commonly handled in this way, and vessels of the turret, trunk or cantilever framed type are illustrative. Frequently ore-carrying vessels have also longitudinal wing bulkheads extending throughout the lower part of the hold, which make an angle with the tank top sufficient to trim the ore in toward the center line so the unloading grabs can clean out the hold.

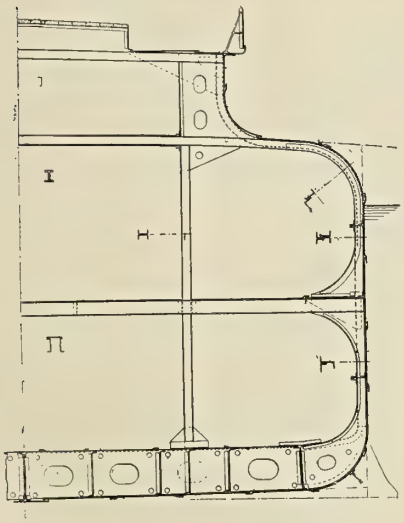


Fig. 1.—Turret Deck

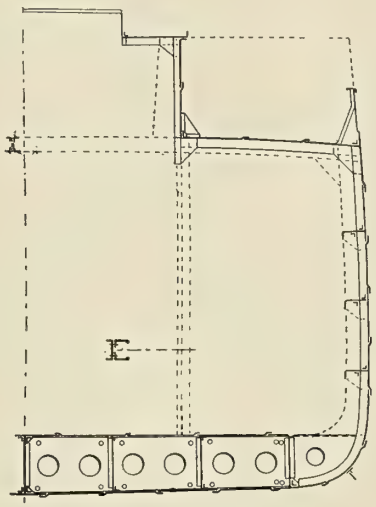


Fig. 2.—Trunk Deck

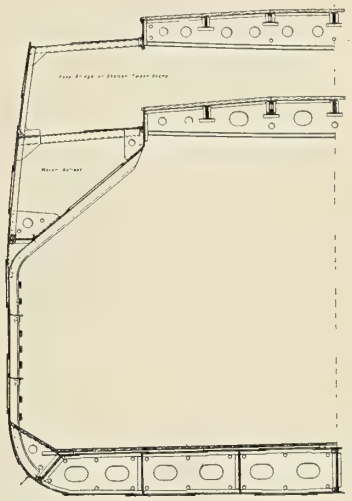


Fig. 3.—Cantilever Framed Type

Effect of Soot on Boiler Tubes

Q.—How much will soot in the tubes of a Scotch boiler reduce its efficiency? B. M.

A.—Soot is a very effective insulator and its effect in decreasing the efficiency of heat transferring apparatus is surprisingly large. It has been stated as the result of experimental investigation that a coat of soot 1/16 inch thick reduced the heat-transferring ability of tubes to 75 percent of that of the clean condition. Gains in efficiency due to cleaning tubes have frequently been reported of 10 percent.

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

Calorific Values of Fuel Gases

Q.—I frequently see in articles which give the results of analyses of fuel gases for gas engines two calorific values quoted, one termed "higher" and the other "lower." Will you please tell me the reason for two values and why there is such a discrepancy; is it due to unavoidable errors in the determination or to some other reason? E. G.

A.—When a fuel gas which contains hydrogen burns, one of the products of combustion is water (H_2O). If the temperature of the burnt gases is below the boiling point of water, the water of combustion remains in the liquid state and the B. T. U.'s found by analysis for this condition is the so-called "higher" calorific value. If, however, the temperature of the burnt gases is higher than the boiling point of water the water of combustion is maintained as steam and requires a certain number of B. T. U.'s to keep it so, or rather renders a certain number unavailable for discharge. The calorific value in this second case is the so-called "lower" value, and differs from the "higher" value by an amount equal to the latent heat of the water of combustion.

In gas-engine work in England, Germany and here, the lower value is usually used in computing efficiencies, but in France the higher value is used; the latter would seem to be the fairer comparison, as the temperatures are always such as to have the water in the form of steam in the exhaust.

Boiler Horsepower and Engine Horsepower

Q.—Please distinguish for me the difference between a boiler-horsepower and an engine-horsepower. Why don't we provide boilers of the same horsepower as the engine has indicated horsepower? J. B.

A.—A boiler horsepower is an arbitrary heat transfer value of 33,455 B. T. U. per hour. An engine horsepower is 33,000 foot pounds of work per minute. The former

was accepted as standard many years ago (1885 and 1898), and on its original acceptance corresponded to the heat necessary to convert 30 pounds of water into dry steam at 84.7 pounds absolute from feed water of 100 degrees F. The steam per horsepower per hour for engines working at about that range was not far from the 30 pounds then accepted, so that then the two (boiler and engine horsepower) were approximately the same. Now there is no definite relationship between the two, as the steam consumption of engines varies from 10 to 60 pounds per hour, depending upon many conditions.

In general, however, a modern engine of any of the common types and ranges of pressure should have an economy of from 200 to 400 B. T. U. per indicated horsepower per minute, or 12,000 to 24,000 per indicated horsepower hour. This would correspond to 33,455 ÷ 12,000 = 2.8 indicated horsepower, which would be handled by one boiler horsepower at the upper limit, and 33,455 ÷ 24,000 = 1.4 indicated horsepower at the lower limit. In designing large plants it is generally considered sufficient to provide boiler horsepower equal to half the indicated horsepower.

Coefficients of Friction of Lubricating Oils

Q.—What should be the coefficient of friction for good lubricating oils used for marine engines? L. O. C.

A.—For a pressure per square inch of projected area of bearing of 60 pounds and a peripheral speed of about 550 feet per minute the values should range from .004 to .0055 for good medium-weight oils. Light oils will run about .0035, and heavy oils about .0065.

Formula for Dimensions of Propeller

Q.—Is there any single formula which will permit one to solve for the dimensions of a propeller when the data known are horsepower, speed and revolutions per minute? E. D.

A.—There have been proposed from time to time a number of empirical formulæ based upon experiments on model propellers or analyses of trials of large wheels, but in general the formulæ have been unsatisfactory. Admiral Taylor has just published * a formula which he considers well representative of the results of experiments made at the United States Model Basin with 120 different model propellers. This formula should prove of inestimable value in those cases where a quick solution of reasonable accuracy is desired, but where it is not desirable to take careful account of all factors affecting design. This formula is given below:

Let P denote the horsepower being absorbed by the propeller (indicated horsepower × engine efficiency = P, or shaft horsepower = P).

V denotes speed of advance of the propeller (not ship) through the water in knots.

d denotes diameter of propeller in feet.

a denotes pitch ratio or pitch ÷ diameter.

R denotes revolutions per minute.

For best efficiency—

$$d = \frac{(P\,V)^{1/6}}{R^{2/3}}\left(63.5 - 50\,\frac{V^{5/2}}{R\,P^{1/2}}\right)$$

$$a = 0.74 + 3.3\,\frac{V^{5/2}}{R\,P^{1/2}}$$

$$\text{Efficiency} = 0.768 - 0.01\,\frac{R\,P^{1/2}}{V^{5/2}}$$

If the diameter given by the above proves too large for the case in hand, another propeller should be used of different diameter and less efficiency. If a reduction in efficiency of 2½ percent is accepted, we can then get a wheel to do the same work on a reduced diameter, for which case Taylor gives the following:

For reduced diameter (efficiency 2½ percent less than maximum)—

$$d = \frac{(P\,V)^{1/6}}{R^{2/3}}\left(57 - \frac{50\,V^{5/2}}{R\,P^{1/2}}\right)$$

$$a = 1.08 + \frac{3.3\,V^{5/2}}{R\,P^{1/2}}$$

$$\text{Efficiency} = 0.743 - 0.01\,\frac{R\,P^{1/2}}{V^{5/2}}$$

* Paper before International Engineering Congress, September, 1915, "Calculations for Ship's Forms, etc.," by D. W. Taylor, Chief Constructor, U. S. N.

NEW BOOKS FOR MARINE ENGINEERS

THE STORY OF THE AMERICAN MERCHANT MARINE. By John R. Spears. Size, 5¼ by 7½ inches. Pages, 340. Illustrations, 16. New York, 1915: The Macmillan Company. Price, $1.50.

This book was originally published in 1910 and reviewed in our issue of June, 1910. The new edition is simply a reprint of the book with the addition of an introductory chapter of 27 pages, giving a brief review of the unusual conditions affecting the American merchant marine in the years 1914 and 1915. Briefly, this is a statement of the demoralizing effect of the European war upon the world's shipping at the commencement of the war, and then of the rapid rise in freight rates and the effect of scarcity of tonnage on the movement of freight over seas, and finally a discussion of the proposed remedies for placing the American merchant marine upon a sound basis for permanent growth after the close of the war.

SAILING SHIPS AND THEIR STORY. By E. Keble Chatterton. Size, 6¼ by 8¼ inches. Pages, 362. Illustrations, 130. Philadelphia, 1915: J. B. Lippincott Company. London, 1915: Sidgwick & Jackson, Ltd. Price, $1.50 net.

A comparison of a modern sailing ship (scarce as this type of vessel is at the present time) with the early sailing vessels from which it was evolved through centuries of gradual development is startling. The increase in size, capacity and speed is indicative not only of the wonderful progress in the art of shipbuilding and in mechanical arts, but also of the rapid expansion of commerce between nations. This book is an authoritative history of this subject, told in an entertaining way and pleasingly illustrated. It will be accepted as a standard work.

DIESEL ENGINES: MARINE AND STATIONARY. By A. H. Goldingham. Size, 5 by 7½ inches. Pages, 206. Illustrations, 135. New York, 1915: Spon & Chamberlain. London, S. W., 1915: E. & F. N. Spon, Ltd. Price, $3.

This book is essentially a practical treatise on the Diesel engine, both stationary and marine, giving in concise form descriptions of the various types and designs of this type of engine. In addition to the descriptive matter, which is carefully written and well illustrated with clear line drawings and photographs, there are chapters containing formulæ for the design and construction of the various parts of the engines, as well as a very carefully compiled chapter on operation and correction which is of special value to a marine engineer who is to operate a Diesel engine. Indicator cards, taken from various two- and four-cycle Diesel engines, are reproduced, together with an explanation of their characteristics.

Marine Articles in the Engineering Press

How the F=4 Was Raised—The American Merchant Marine—Trials of New Destroyers and Coast Guard Cutters

Trials of Coast Guard Cutters Ossipee and Tallapoosa.—The trials of the two new cutters for the United States Coast Guard were run on June 22 and June 29, 1915. The two vessels are built to the same lines except that the forward end of the under water body of the *Ossipee* is modified by cutting away the forefoot to enable the vessel to better cope with the winter ice conditions on the Maine coast. Both vessels were fully described in the January, 1915, issue of INTERNATIONAL MARINE ENGINEERING. On the full two-hour, full-power trial of the *Ossipee* the speed developed was 12.55 knots with the engines developing 1,195 indicated horsepower. A speed of 12.66 knots was obtained with the *Tallapoosa* at an indicated horsepower of 1,131. On these trials, which were run in the Hampton Roads and Chesapeake Bay, the *Ossipee* had a displacement of 785 tons and the *Tallapoosa* 748 tons. 1 illustration. 2,800 words.—*Journal of the American Society of Naval Engineers,* August.

The Torpedo.—This article gives a detailed description of the Whitehead type of torpedo now in use in practically every naval department in the world. The development of the Whitehead torpedo is traced from the year 1860, when a Captain Luppis, of the Austrian Navy, conceived the idea of a boat for coast defense, dirigible for a distance and carrying an explosive charge to be fired by a contact device. Captain Luppis became associated with Mr. Robert Whitehead in 1864, and the mechanical development of the torpedo was begun. The modern Whitehead torpedo is described by taking up in succession each of the eight main subdivisions into which the torpedo is divided—that is, percussion or firing device, explosive head, the air chamber containing highly compressed air, balance chamber containing the control gearing, engine room containing driving mechanism, buoyancy chamber, bevel wheel chamber and rudders and propellers. 2 illustrations. 3,700 words.—*The Marine Engineer and Naval Architect,* August.

Twin Screw Steamer Jean Pieterszoon Coen.—The largest steamer so far built in Holland is described as having been built by Ned. Scheepsboun Maatschappy for service to Java, with the dimensions 503 feet 6 inches by 60 feet 4 inches by 39 feet by 25 feet draft and 15,600 tons displacement, 6,950 tons of the latter being available for cargo. She is built according to British Lloyd's with an almost complete double bottom for drinking, ballast and feed water. There are eight watertight transverse and watertight longitudinal coal bunker bulkheads and six decks. Cargo is stowed in five holds and handled by one 25-ton, four 6-ton and two 3-ton booms and eight 2-ton hydraulic cranes. The ship is fitted with two masts and two smokestacks and has fourteen boats, 28 feet by 8 feet 6 inches by 3 feet 6 inches, of which two are motor boats, giving safe accommodation to all passengers and members of the crew. The rudder has double operating gear, one hydraulic-electric and one steam; the watertight doors can be closed by the Stone-Lloyd system; the signal service consists of an underwater sound system and overhead wireless telegraphy. The electric plant of three 200-kilowatt, 115-volt turbo-generators supplies current for the electric light and power for ventilators, wall clocks, Suez Canal searchlights, etc. Passenger accommodations are for 175 first class, 128 second class, 46 third class and 44 fourth class, and 243 members of crew, with luxuriously fitted social rooms, 4 cabins de luxe, 47 single, 60 double cabins, children's dining room, gymnasium, photographic dark room, etc. The machinery plant consists of two engines, 26¾ by 44 by 75 inches diameter by 50 inches stroke, which at 85 revolutions per minute indicate 6,000 indicated horsepower, giving the ship a speed of 15 knots. There are eight three-furnace single-ended boilers of nearly 21,000 square feet heating surface, built for 214 pounds per square inch working pressure. Among the auxiliaries are the usual steam pumps, fire pumps, hydraulic plant, steam winches and windlass, evaporating and refrigerating plant. 11 illustrations. 840 words.—*Schiffbau,* November 19.

Systematic Propeller Tests at the Experimental Basin of the German Government, Berlin.—It is stated that in addition to the tests made with a propeller of an area ratio of 30 percent, tests were made for this series A with those of area ratios of 25, 30, 40, 50 and 60 percent and plotted as functions of the revolution-thrust curve, that means suitable for cases where a certain thrust shall be realized with given revolutions and speed. It is pointed out how the interrelation between areas, efficiencies and thrust varies according to certain given or fixed factors, referring again to a previous numeral example at 30 percent ratio, extending the analysis over the entire range of area ratios and considering at the same time the effect cavitation might have upon practical results. The analysis is carried out also for the entire area ratio in application to tugboat propellers, with the conclusion that their best efficiency is gained from large area and a fine pitch. An appendix contains the mathematical development of the efficiency limit of an ideal propeller. 15 illustrations. 3,540 words.—*Schiffbau,* October 27.

Salvage of the Submarine F-4.—By Naval Constructor J. A. Furer, U. S. N. The first attempts to raise the United States submarine *F-4*, which sank on March 25 at a point about a mile and a half outside of Honolulu harbor, where the depth of water varies from 295 feet to 315 feet, proved fruitless, as the application of an upward pull of about 100 tons by means of a dredge and towing inshore with all the power available failed to move the submarine. The next method of salvage involved the use of two substantially built mud scows, 104 feet by 36 feet, with lifting gear consisting of improvised windlasses actuated by hoisting engines installed on each scow. Two steam-driven pumps were installed on each scow, so that in case it should become necessary to use more power for starting the submarine off the bottom than could be delivered by the hoisting engines, the buoyancy of the scows could be called on. This was necessary only once, however. A dredge from which the boom and bucket gear had been removed was used as the central unit of the salvage plant. The dredge was equipped with a 10-inch by 14-inch engine geared to six drums, any one of which could be operated independently of the other. After innumerable difficulties, two slings were placed under each end of the submarine, but, after lifting the boat about 25 feet and towing inshore to a new landing, one of the hawsers parted; while it was being replaced, bad weather

set in, and presently all of the other hawsers parted. Just one month from the date of the accident not a single line remained around the vessel, and the only measurable progress was a reduction in the depth of water from 300 to 275 feet. Chain slings were substituted for wire slings, and the vessel was lifted 225 feet in a few days and towed inshore to a spot just off the channel entrance, where the depth of water was only 50 feet. A heavy ground swell set in, however, which wrecked the salvage operations. A large rent was found in the hull forward where the chains from one of the scows had ripped through the shell plating. Lifting by the windlass method was then considered unsafe, as it was likely that the forward end of the submarine would break off under the strain. A new plan was accordingly adopted, consisting of the use of six specially constructed pontoon cylinders 32 feet long, four being 11 feet in diameter, and two 12 feet 6 inches in diameter. The combined lifting capacity of the six pontoons was 420 tons. The plan called for the lifting of the vessel by means of six chains. After all six cylinders had been landed on the bottom alongside the vessel and the chains properly secured, the water was forced out of the cylinders by the use of compressed air. This method proved successful in every way, and the vessel was brought to the surface on August 29 and docked the following day. 6 illustrations. 4,300 words.—*Scientific American,* October 16.

The U. S. S. Wadsworth.—The United States destroyer *Wadsworth,* which was authorized by Congress March 4, 1913, was built by the Bath Iron Works, Ltd., Bath, Me. She is a twin screw vessel driven by Parsons turbines fitted with reduction gear and designed for a speed of 30 knots at a displacement of about 1,050 tons with the turbines developing 17,500 shaft horsepower. Steam is supplied by four Normand watertube boilers. The hull is 315 feet 3 inches long overall, 310 feet long on the waterline, 29 feet 8⅛ inches beam on load waterline, mean draft 9 feet 4½ inches, block coefficient, .44. The article gives a general description of the hull; the battery, which consists of four 4-inch rapid fire guns and four 21-inch twin torpedo tubes mounted on the main deck; the steering engine and gear, fire main, flushing system, fresh water system, drainage system, ventilation, heating system and main and auxiliary machinery. The turbines are of the standard Parsons reaction high-speed type, the high-pressure rotor turning at 2,494.5 revolutions per minute and the low-pressure rotor at 1,509.8 revolutions per minute when driving the screws at the designed speed of 450 revolutions per minute. The high-pressure turbines are fitted with cruising stages and the low-pressure turbine with reversing stages. The reduction gears are of Parsons design, each unit consisting of two forged steel pinions forged integrally with their shafts driving a main gear. The main gear is secured to its shaft by bolts, two collars being provided on the shaft for the purpose. It is of the built-up type, consisting of a forged steel rim securely bolted to two steel plate disks forming a wheel, the whole being cross-braced by cast steel cone fitted between the disks and through bolted with the after disk to the rim with the forward disk to its shaft collar The gear and pinions have helical cut teeth. The pinion shafts are direct connected to the turbines, the high pressure turbine driving the outboard pinion and the low pressure turbine the inboard pinion. The gear shaft is coupled direct to the main shaft and on its forward end is fitted the main thrust bearing of the Kingsbury pivoted type. The propellers are 7 feet 7¾ inches diameter and the pitch 8 feet 7½ inches. The trials of the *Wadsworth* were conducted from June 21 to 24, 1915. The contract speed was exceeded without effort and the fuel oil consumption guarantees were improved beyond expectation. On the full-power trial a speed of 30.72 knots was attained with a shaft horsepower of 16,129. The oil burned per knot run at this speed was 506.94 pounds and the water used by the main turbines and condenser augmenter only per shaft horsepower was 11.19 pounds. At a speed of 30.685 and a horsepower of 16,100, the water consumed by all of the machinery per shaft horsepower was 12.533 pounds. 4 illustrations. 8,000 words.—*Journal of the American Society of Naval Engineers,* August.

The Merchant Marine from a Southerner's Viewpoint.—By William Gatewood. The author of this paper, who is naval architect of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., shows along what lines the commerce of the United States has grown so that at the present time its foreign commerce is composed of two distinct parts. Staple products from the abundant natural resources of the country are still exported, but, on the other hand, a large quantity of manufactured products are also exported, which was not the case in former days, when the American merchant marine was carrying most of the country's trade. He points out that the commerce of the United States is likely to save the country from panic and from great general distress until the termination of the present war. And in future the natural resources of the country and the skill of its people in manufactures will make commerce a leading feature in the life of the country. Exports will increase by leaps and bounds and, with increased wealth, imports will increase equally as rapidly. As it is self-evident that the commerce of the United States will continue to grow, it becomes of great imortance that the advantages to be derived from its transportation should be appreciated at their true value. The greatest advantage of the carrying trade probably is the profit which it yields to the country which engages in it. The author cites cases to show that profits will accrue to a country in far greater measure even if Government assistance in the form of a subsidy or in some other manner has to be paid to the operating transportation companies to meet the cost of transportation, as against a lower rate of foreign competitors. The only case in which no saving would be shown in a country on account of carrying its own commerce would be in the case of such a dearth of labor that none could be spared from absolutely essential works in the country. Such a condition does not now exist in the United States, and it is apparent that there is no likelihood of such a condition ever arising, as that is a state of affairs in the infancy of a country or after a national calamity. The beneficial results of spending the money expended for transportation charges in the country which fosters the transportation business is easily shown to be widespread —in fact, almost universal. In view of the fact that under the present conditions assistance must be given to the American merchant marine, the author shows that, while there may be a thousand other ways of granting the necessary assistance, all except the imposition of an additional duty on articles imported in foreign bottoms contemplate taking money from the general public to pay the subsidy or make up the deficit. The advantages of the best method for providing this assistance should be made so that the assistance may be granted in direct proportion to the need. 4,500 words.—*The Journal of the American Society of Marine Draftsmen,* October, 1915.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

Between fifteen and twenty bulk Lake freighters have changed hands in the past few weeks, nearly all being taken over by shippers and consuming interests. Eight bulk freighters have been ordered from Lake shipyards for delivery in 1916, and they will be operated by shippers or managers having connections with ore firms.

The most important deal that has been made in Lake vessel property recently was closed a few days ago when M. A. Hanna & Co. and the Cambria Steel Company, jointly purchased four modern steamships from the Frontier Steamship Company and one from the Niagara Transit Company. These vessels have a combined carrying capacity of about 70,000 tons per trip.

In addition, this firm has recently secured control of four other large steamers.

Contracts for New Ships

The William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., has received contracts from the Mexican Petroleum Company, New York, to build two large oil tank steamships, and also a contract from the Florida East Coast Railway Company, St. Augustine, Fla., to build a duplicate of the car ferry *Henry M. Flagler*.

The New York Shipbuilding Company, Camden, N. J., has a contract from the Coastwise Transportation Company, Boston, Mass., to build a collier of about 8,500 tons deawweight carrying capacity, and a contract from the Pocahontas Navigation Company, New York, to build a large collier.

The Harlan & Hollingsworth Corporation, Wilmington, Del., has received a contract from the Ocean Steamship Company, of Savannah (Savannah Line), New York, to build a large freight and passenger steamship.

The Fore River Shipbuilding Corporation, Quincy, Mass., has received a contract from the Luckenbach Steamship Company for the construction of two additional 10,000-ton freight steamers to be delivered in about twenty-four months. With the present contracts, the Luckenbach Company has placed orders calling for no lass than five new 10,000-ton steamers, some of which are nearing completion.

The Maryland Steel Company, Sparrows Point, Md., has received a contract to build two large vessels for a Cuban Ore Company.

The Great Lakes Engineering Works, Detroit, Mich., has received a contract to build two new ships designed by George Simpson, naval architect, New York, for Adler, Inc., of Birmingham, Ala.

Orders for four new motor-propelled ships of 3,500 tons each, to be delivered next autumn at a price of $200,000 (£41,000) each have been placed at Baltimore.

The New York Navy Yard has received the contract for the United States super-dreadnought No. 43, to be built at a cost of $7,690,925 (£1,575,000).

The Mare Island Navy Yard, California, has received the contract for building the United States super-dreadnought No. 44 at a cost of $7,413,156 (£1,520,000).

The Harlan & Hollingsworth Corporation, Wilmington, Del., has received a contract from the Vacuum Oil Company for an oil tanker of 50,000 barrels capacity, and also for a freight steamer with a capacity of 3,500 tons of general cargo.

The Union Iron Works, San Francisco, Cal., has received a contract from the Vacuum Oil Company for an oil tanker with a capacity of 75,000 barrels.

The Canadian Government has decided to give every possible encouragement to the building of ships to accommodate the British Columbian lumber trade. An issue of bonds is to be authorized by the government to provide for building thirty four-masted ships to be turned over to the lumber manufacturers of British Columbia, who will pay for the ships as the bonds fall due. Enough bonds have already been subscribed to lay the keels of six of the new ships in the spring.

The American Shipbuilding Company, Cleveland, Ohio, has received a contract from M. A. Hanna & Co., Cleveland, to build a 524-foot steamship of about 9,500 tons capacity. This order makes eleven steamships that the American Shipbuilding Company has under contract for delivery in 1916.

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has received a contract from the Southern Pacific Company, New York, to build two freight steamships and one oil tank steamship, and also from another source a contract to build another oil tank steamship. Including the above orders, the Newport News Shipbuilding & Dry Dock Company has received contracts this year to build twenty-four steamships, exclusive of naval orders.

The Maryland Steel Company, Sparrows Point, Md., has received a contract from the Munson Steamship Line, New York, to build a passenger steamship. This makes the third steamship which the Munson Line has recently ordered of the Maryland Steel Company.

The Union Iron Works Company, San Francisco, Cal., has received a contract to build two oil tank steamships 435 feet long, and also a contract from another concern to build an oil tank steamship 435 feet long.

The Collingwood Shipbuilding Company, Collingwood, Ont., has received a contract from the Montreal Transportation Company, Montreal, Canada, to build a 550-foot freight steamer.

Joseph Supple, Portland, Ore., has received a contract from the Kitsap Transportation Company, Seattle, Wash., to build a 150-foot river boat.

Whittlesey & Whittlesey, naval architects, New York, have designed a 200-foot steel passenger steamship to be operated in the vicinity of New York.

Nilson & Kelez, Seattle, Wash., have received a contract from the Pacific American Fisheries Company, Bellingham, Wash., to build a light draft twin screw freight boat 100 feet long, to be equipped with two 80-horsepower oil engines.

The Kelley-Spear Company, Bath, Me., will build two derrick lighters for the New England Steamship Company, Boston, Mass.

The Matthews Shipyard Company, Hoquiam, Wash., will build a wooden steam lumber schooner for the S. S. Freeman Steamship Company, San Francisco, Cal.

The Tietjen & Lang Dry Dock Company, Hoboken, N. J., will rebuild the steamship *Dunholme*, belonging to the Merritt & Chapman Derrick & Wrecking Company, New York.

The Standard Shipbuilding Company, West Brighton, Staten Island, which recently purchased and is now operating the shipbuilding yard of the old Shooters Island Company, is stated to have received orders to build four 6,000-ton freight steamers.

The Continental Trading Company, Mystic, Conn., a new shipbuilding company, is reported to have received orders to build three steamers for Norwegian interests.

Shipbuilding Contracts Pending

The city of Astoria, Ore., is planning to operate boats from that city to Lewiston, Idaho, and it is said that work will shortly be started on the construction of the boats to navigate the Columbia and Snake rivers. The work is in the hands of Captain Arthur Riggs, of Astoria.

The Department of Commerce and Labor, Washington, D. C., will soon advertise for bids for a lobster vessel to be used on the coast of Maine. The appropriation available is $45,000 (£9,200).

It is announced that the Southern Pacific Company, New York, will shortly order another large tank steamship.

The Port of Seattle (Wash.) Commission, J. R. West, chief engineer, contemplates building a ferry steamer to cost $30,000 (£6,150).

Shipyards on the North Pacific coast have been asked for bids to build twelve barges, 130 feet by 34 feet by 9 feet, having a capacity of 300 tons and six gasoline (petrol) tugs, two of 80 horsepower, four of 50 horsepower, and four smaller power barges to be equipped with machinery for harvesting seaweed from Alaskan coast waters.

The Midvale Steel & Ordnance Company, Philadelphia, Pa., is reported to have purchased extensive iron ore deposits in Cuba, and in connection with this project it is stated that the company contemplates the building of steamers to ply between Cuba and Atlantic ports.

New 11,500-Ton Werkspoor-Engined Ship

The steamship *Ombilin* was recently launched by the Netherlands Shipbuilding Works to the order of the Royal Packet Steamship Company, which already owns four Werkspoor-Diesel-engined ships, the low operating costs of which recently were published. The new vessel is to the highest class of the Bureau Veritas, and is the largest of the company's fleet. In addition, she is the first ship to be fitted with topside tanks ever built in Holland. Her dimensions are 420 feet by 54 feet by 27 feet, displacement 11,500 tons on 22 feet 6 inches draft. The accommodations for officers, engineers and crew are aft. She has four large, clear holds without 'tweendecks or beams.

All latest improvements for expeditiously handling the cargoes have been fitted, including 16 steam winches and derricks for lifting 30 tons. Her steam windlass is of the Clarke-Chapman type, and the steam steering gear of the Donkin type. The machinery is being supplied by the Netherlands Engineering Company (Nederlandsche Fabriek van Werktuigen en Spoorwegmaterieel), of Amsterdam, builders of the Werkspoor-Diesel engines. The engines are of the triple expansion type, with cylinders 24½ inches, 40½ inches and 67 inches diameter by 48 inches stroke. She will have three single-ended Scotch boilers, working under a pressure of 180 pounds per square inch, fitted with Howden's forced draft.

Shipyard Extensions and Improvements

It is stated that the Union Iron Works, San Francisco, Cal., will build a floating dry dock and make other improvements at a cost to exceed $1,000,000 (£205,000).

It is reported that the Texas Oil Company has purchased the shipbuilding plant of Arthur Sewall, Bath, Me., and will shortly commence the construction of a fleet of twenty steel barges for transporting oil in bulk.

The Morse Dry Dock & Repair Company, Brooklyn, N. Y., is planning to build the largest sectional floating dry dock in the country at the foot of Fifty-eighth Street, Brooklyn. It is said that this dock will have a lifting capacity of 27,000 tons.

The St. Helens Shipbuilding Company, St. Helens, Ore., is considering enlarging its plant to enable the company to lay down steel hulls with a maximum length of about 350 feet.

The plant of the John H. Dialogue Company, Camden, N. J., was sold at auction on December 8, to interests which, it is reported, will reorganize the company and reopen it for shipbuilding purposes.

It is reported that the Bethlehem Steel Company, South Bethlehem, Pa., is planning to build a large shipyard at Newcastle, Del.

Contracts for Piers, Wharves and Marine Terminal Improvements

The Link Belt Company, Chicago, Ill., has received a contract from the Gulf, Florida & East Coast Railway, Pensacola, Fla., to build a coal pier at Pensacola.

O. L. Olesen, 133 Moraine Road, Highland Park, Ill., has received a contract to build piers at Evanston, Ill.

The Duluth & Iron Range Railway Company, Duluth, Minn., is reported to be planning to build two ore docks at Two Harbors, Minn., at an estimated cost of $1,500,000.

It is reported that the Pennsylvania Coal & Supply Company, Milwaukee, Wis., will build new docks at Muskegon avenue and Canal street, Milwaukee.

The city of Chattanooga, Tenn., R. Hooke, city engineer, is planning to improve its wharves and to issue $100,000 (£20,500) in bonds for that purpose.

It is reported from San Francisco, Cal., that a contract will soon be awarded to build a pier at the foot of Chestnut street, to cost about $250,000 (£51,300).

It is reported that the New York Dock Company, foot of Montague street, Brooklyn, N. Y., will spend about $1,250,000 (£256,000) in wharves and piers on the Brooklyn water front.

The Board of Port Commissioners of New Orleans, La., will construct some new wharves. Plans and specifications are on file with Ford, Bacon & Davis, New Orleans.

It is announced that J. J. Kane, Galveston, Tex., will spend about $1,000,000 (£205,000) on a dry dock in Galveston harbor instead of $500,000 (£102,500) as at first planned.

The Minneapolis, St. Paul & Sault Ste. Marie Railroad, C. N. Falk, chief engineer, Minneapolis, Minn., has prepared plans for a large concrete ore dock at Ashland, Wis.

Snare & Triest, Woolworth Building, New York, will build a pier at Deep Water Point, Wilmington, Del., for the Dupont Powder Company, Wilmington.

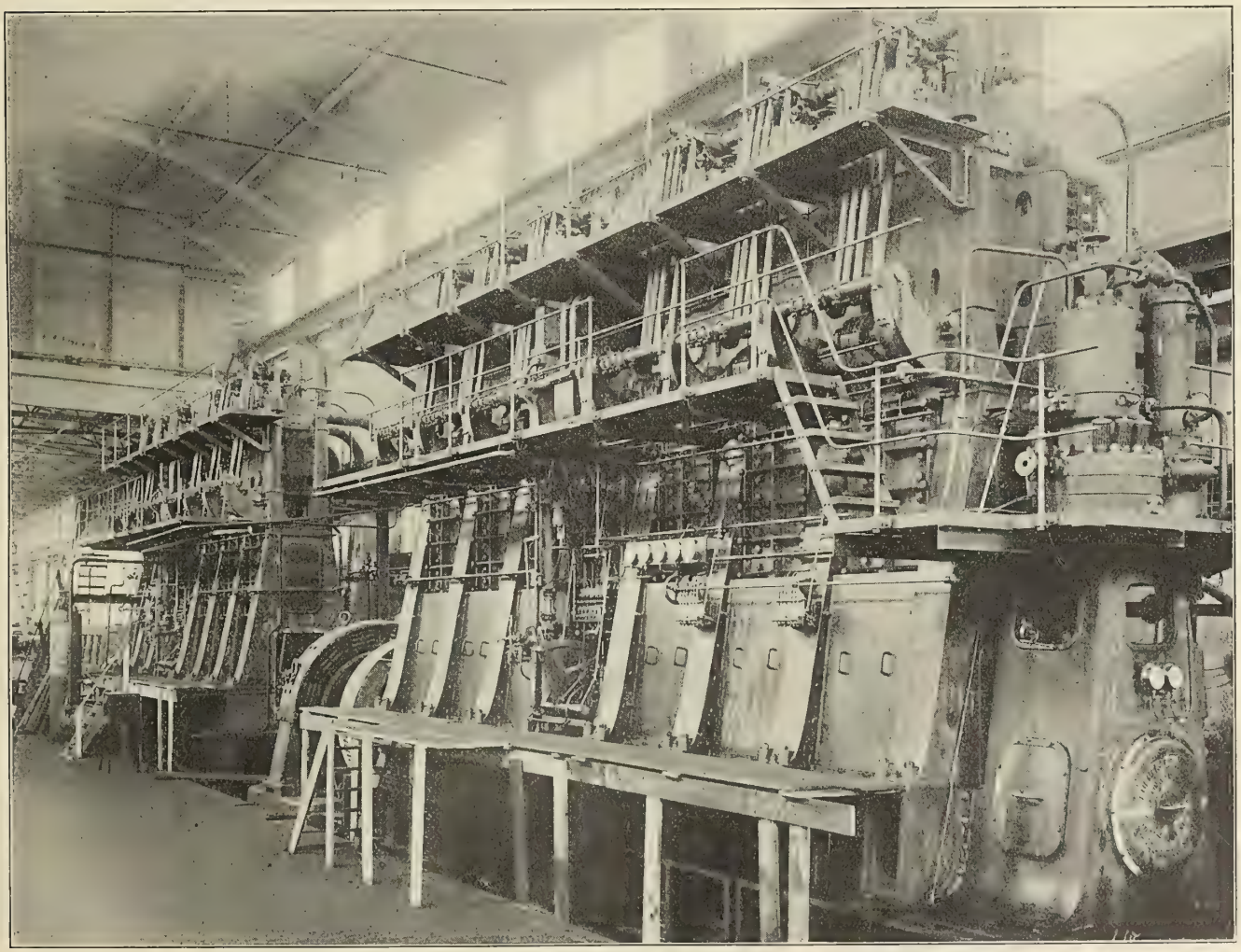
The Charleston Engineering & Construction Company, Charleston, S. C., has received a contract amounting to $55,000 (£11,300) to build a wharf at Tradd street, Charleston.

The city of Houston, Texas, is planning to spend $1,000,000 (£205,000) for wharves and piers next year.

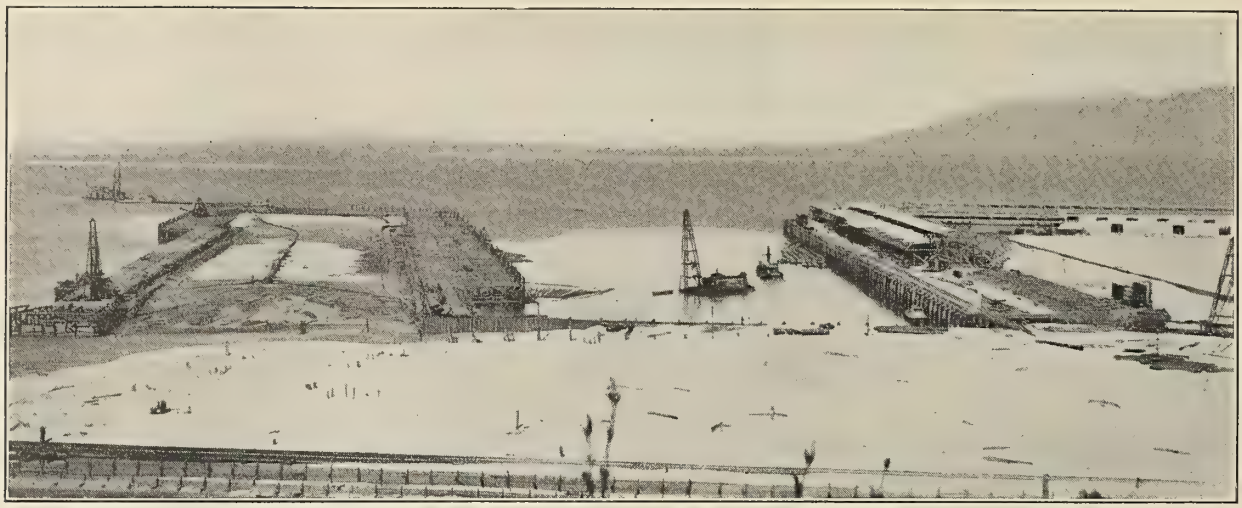
Motor Ship *Australien*, Built by Burmeister & Wain for the East Asiatic Company

During the past two years the city of New York, through Commissioner of Docks and Ferries, R. A. C. Smith, Pier A, New York, has begun work on almost seven miles of wharfage space. These new piers will furnish 1,973,000 feet of dock space. Among the improvements are the 1,050 foot piers at Forty-fourth street and Forty-sixth street, North River, which will accommodate the largest liners now afloat or to be built for many years to come.

The city of Beaumont, Tex., has let a contract to John O. Kelley, of Beaumont, to build a 500-foot concrete wharf at a cost of about $60,000 (£12,300).



Six-Cylinder, Four-Stroke, Single-Acting Diesel Engines for the Motor Ship *Australien*



Rail and Water Terminals Under Construction at the Mouth of the Columbia River at the Port of Astoria

The Erie Railroad Company, New York, will build ore docks at Cleveland, Ohio, to cost about $200,000 (£41,000).

The Merchants and Miners Transportation Company, Baltimore, Md., has given the contract to the Hillyer & Spearing Company, Jacksonville, Fla., for dock improvements at Jacksonville to cost $75,000 (£15,400).

The Barnett & Record Company, Duluth, Minn., will build a $90,000 (£18,400) dock for the M. A. Henner Coal Company.

The General Chemical Company, Marcus Hook, Pa., has awarded a contract to John Monks & Sons, New York, to build a pier at a cost of $200,000 (£41,000).

Ford, Bacon & Davis, contracting engineers, New Orleans, La., are drawing plans for construction of docks, terminals, etc., for the city of Mobile, Ala.

Doullutt & Williams, New Orleans, La., will build a grain elevator wharf for the Port Commissioners of New Orleans, at a cost of $188,000 (£38,500).

The city of Miami, Fla., received bids until December 20 for the construction of piers and other improvements. Isham, Randolph & Co., Chicago, Ill., are the engineers.

John O. Kelly, San Antonio, Tex., will build a wharf for the city of Beaumont, Tex., at a cost of $65,000 (£13,300).

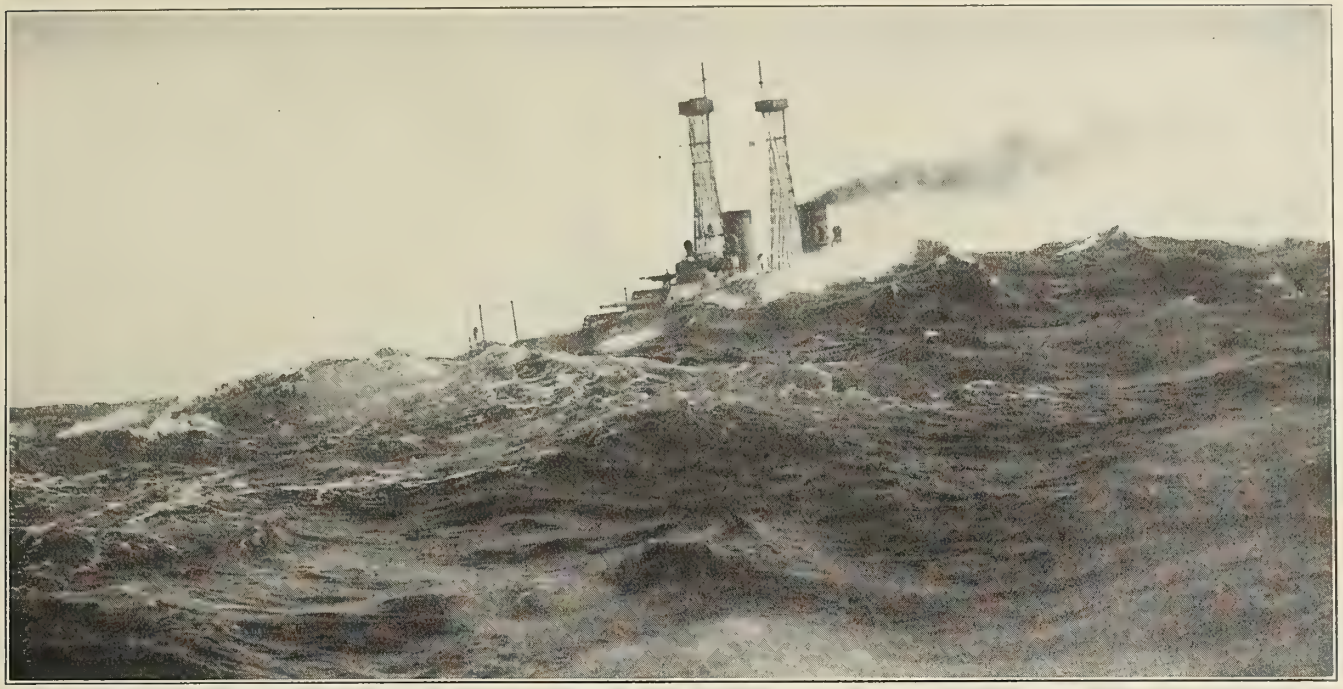
The Baltimore & Ohio Railway Company, F. L. Stuart, chief engineer, Baltimore, Md., has awarded contracts for constructing and equipping a coal pier at Curtis Bay to H. S. Kerbaugh, Inc., Baltimore, Md.

The American Bridge Company, New York, has been awarded a contract to build the superstructure of the concrete ore dock for the Duluth & Iron Range Railway Company, Duluth, Minn., at Two Harbors, Minn., at a cost of about $1,635,000 (£336,000).

Launch of Collier Bylayl

The New York Shipbuilding Company launched at Camden, N. J., on December 4 the collier *Bylayl* for the Pocahontas Navigation Company. The vessel is of the same type as the *Norfolk,* built by the New York Shipbuilding Company for the Coastwise Transportation Company, and is 319 feet long between perpendiculars, 49 feet 3 inches beam molded, 27 feet 6 inches depth molded, and with a draft of 22 feet 8 inches has a deadweight carrying capacity of 5,450 tons. The propelling machinery, which is placed aft, consists of a triple expansion engine of 1,800 indicated horsepower, supplied with steam at 200 pounds pressure by two-single-ended Scotch boilers. The designed speed at sea loaded is 10½ knots.

S. S. *Franklin,* Seventh Collier Built by the New York Shipbuilding Company for the Coastwise Transportation Company, Boston, Mass.



United States Battleship *Delaware*, Ploughing Through the Heavy Seas of the North Atlantic

Trials of Motor Ship Columbia

The official trials of the motor ship *Columbia,* built by Burmeister & Wain for the East Asiatic Company, were carried out in Copenhagen Sound last month. Like the *Australien,* illustrated on page 41, and the other sister ships of the East Asiatic Company's fleet of motor ships, the *Columbia* is 425 feet long between perpendiculars, 55 feet beam, 30 feet 6 inches depth, with a deadweight carrying capacity of 9,500 tons on a draft of 26 feet 5 inches. The main Diesel engines develop 1,550 indicated horsepower at 125 revolutions per minute, which gives the ship a speed of 11.15 knots.

The auxiliaries are driven by electricity generated by three two-cylinder auxiliary Diesel engine sets of 90 brake horsepower each.

During the trial trip a speed of 12.05 knots was attained at 3,315 indicated horsepower at 142 revolutions per minute. The fuel consumption of Solar oil was .31 pound per indicated horsepower hour for all purposes.

United States Coast Guard Cutter *Seneca* Passing Between Two Large Icebergs While Patroling the North Atlantic Steamship Lanes

ENGINEERING SPECIALTIES

Savings Made by Oxy-Acetylene Cutting Torch

The wrapper sheets in three boilers on the steamship *H. M. Whitney,* of the Eastern Steamship Company, were cut out recently at Boston, Mass., by two men in six days

Cutting Out Wrapper Sheet in Boiler on Steamship *H. M. Whitney* with Imperial Oxy-Acetylene Torch

of eight hours each by means of oxy-acetylene cutting torches. The superintendent of the company states that this work would ordinarily take nine boiler makers and helpers eighteen days if the job were done by hand. Nine men working eighteen days would make a total of 1,296 hours. On the other hand, two men working with a torch for six days at eight hours each equals ninety-six hours. Hence there is a total saving of 1,200 working hours on this job. Figuring the average wage of boiler maker and helper at 40 cents (1/8) per hour, which is very low, there is a saving of $480 (100/0/0) on this one job.

The oxy-acetylene cutting apparatus used in this case was supplied by the Imperial Brass Manufacturing Company, Chicago, Ill.

120-Horsepower 4-Cylinder Nlseco Diesel Engine

The New London Ship & Engine Company, Groton, Conn., has placed on the market a vertical, single-acting, four-cylinder Diesel engine of the four-cycle type, which is rated at 120 horsepower. The details of construction of this engine are similar in every respect to those of the 60-horsepower Nlesco Diesel engine described in our November issue. Reversing is obtained by means of a heavy duty type of mechanical reverse gear and clutch. This reverse gear is shown in the photographs, Figs 2 and 3, but is not shown in the drawing, Fig. 4.

The engine has four working cylinders, 9 inches diameter and 12½ inches stroke, and develops 120 horsepower at 350 revolutions per minute. At the forward end of the engine there is a two-stage tandem-type air compressor

Fig. 1.—Cannery Tender *Chomly*

for supplying air for injecting the fuel and for starting purposes, provision being made for regulating the pressure carried on the spray air by means of a throttle on the first stage suction. The weight of the engine complete with flywheel, clutch and thrust bearing is about 16,500 pounds.

A number of these four-cylinder 120-horsepower engines have already been built and installed, and the owners report that their performance has been uniformly satisfactory. An example of the economy, reliability and remarkably light cost of upkeep of one of the engines is

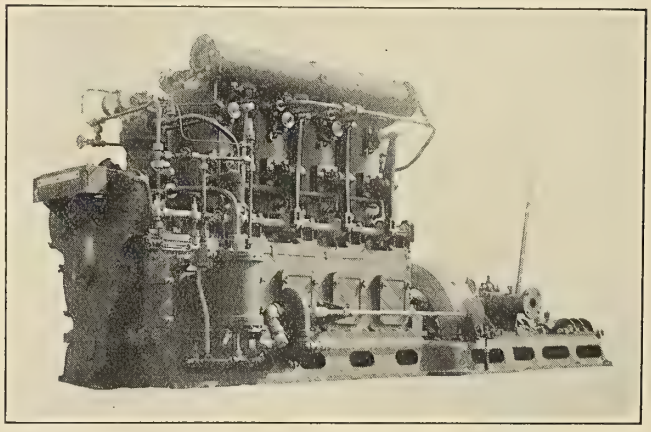


Fig. 2.—Exhaust Side of the Engine

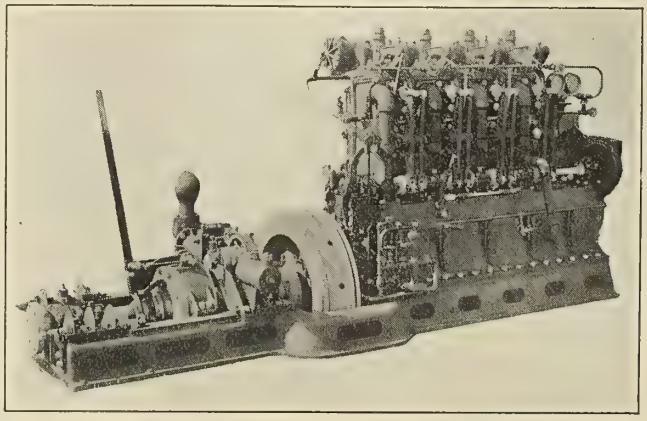


Fig. 3.—Working Side of the Engine

summed up in the following: The cannery tender *Cholmy*, a boat 78 feet long, 18 feet beam and 8 feet depth, heavily built on towboat lines, owned by the Alaska-Pacific Fisheries, of Seattle, Wash., and Portland, Ore., is equipped with such an engine. The boat went into commission May 13, 1915. Her first run from Seattle, Wash., gallons of fuel oil was consumed, this being at the rate of 5.8 gallons per hour, which, at the price of fuel oil at Seattle (95 cents per barrel) gives a roughly running cost for this vessel of 13.1 cents, or a total fuel bill for the season of $195.97 (£40). During the entire season the only expenditure for repairs amounted to only $2 (8/4).

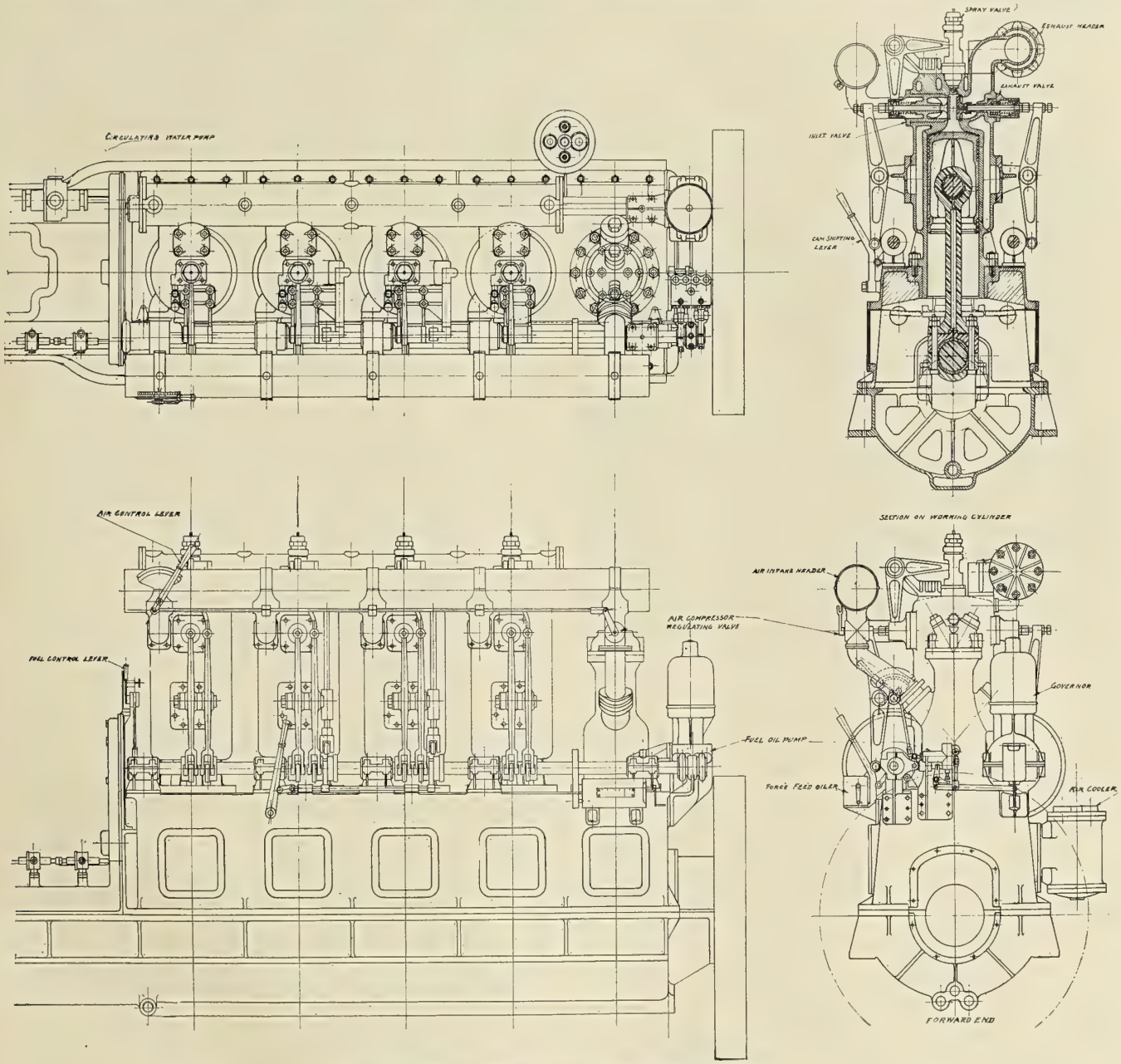


Fig. 4.—Nlseco 120 Horsepower Diesel Marine Engine

to Ketchikan, Alaska, a distance of 754 miles, was made in 882 hours, the engine burning only 6 gallons per hour of 2¼-cent fuel oil, making a cost of 13½ cents per hour for fuel. The cost of lubricating oil was 2⅔ cents per hour, making the combined fuel and lubricating cost 16 1/6 cents per hour.

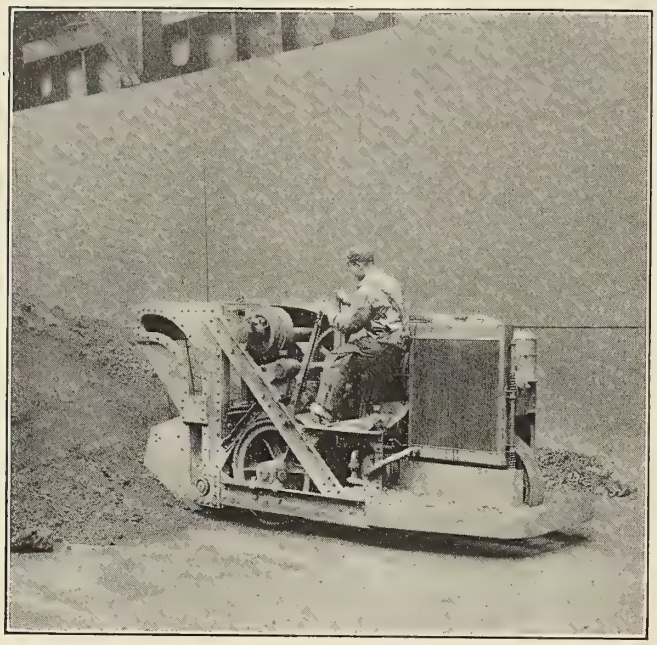
In the North the *Cholmy* operated from the Cholmy, Alaska, cannery for four and a half months, doing heavy duty work in towing scows, pile drivers and brailing fish at the traps. Having finished her season's work in the North, the *Cholmy* made a return non-stop run of 754 miles, arriving at Seattle in splendid condition. The engine room log of the *Cholmy* shows for the season a working time of 1,989 hours, during which a total of 8,664

Power Scraper Shovel for Handling Bulk Cargoes in Holds of Vessels

In unloading boats of ore or coal there is always a certain amount of material that lies between the hatches and cannot be reached by the unloading grabs. The "Brownhoist" power scraper shovel illustrated, which was developed by Mr. S. J. Russell, dock superintendent on the Buffalo, Rochester & Pittsburgh Railroad Company's dock at Buffalo, and is now manufactured by the Brown Hoisting Machinery Company, Cleveland, Ohio, is designed to place this material between the hatch openings, thereby doing away with hand shovelers.

The "Brownhoist" power scraper shovel consists of a high-powered gasoline (petrol) engine operating a shovel

located at the front end of the machine. When the shovel is raised to its top limit it is in a dumping position and the load falls out. The entire mechanism is mounted on two rubber-tired driving wheels with a third wheel in the rear as a trailer and steering wheel. The two driving wheels are connected to the engine by means of gearing and clutches so as to move the shovel back and forth. The hoisting drums for raising the shovel and dumping it are also connected to the engine through gearing and clutches. All operations are controlled by the operator by means of levers in front of his seat. Brakes are supplied so as to give the operator better control of the operation.



Brownhoist Power Scraper Shovel at Work in Hold of Steamer

When handling ore or coal in the hold of a vessel the shovel pushes the material to the desired point instead of picking up a shovelful at a time and depositing it there. This makes the operation much faster, as more material than one shovelful is handled at each trip. When working in the bow or stern, or against bulkheads, it is necessary to handle the material a shovelful at a time, carrying the material to the hatch. In this work the power shovel effects a marked saving of time over hand shoveling. From the results obtained in service, it is found that a vessel is released anywhere from one to five hours sooner than when hand shovelers are used. It saves the cost of from 12 to 40 shovelers, depending on the type of boat.

Babcock & Wilcox Watertube Boilers to be Installed in New Vessel for the Matson Navigation Company

The Babcock & Wilcox Company has recently received an order from the Matson Navigation Company of San Francisco for eight large boilers and superheaters for their new passenger and freight ship now building. This vessel will operate between San Francisco and Honolulu, and will be a companion vessel to the *Matsonia,* which has been in operation for several years. It is expected that the power developed on the new vessel will be approximately 11,000 horsepower.

The Matson Navigation Company purchased Babcock & Wilcox boilers for their tug *Navigator* in 1907, and the success of the boilers on this small vessel (which first proceeded to San Francisco from Newport News under her own steam, and then went into service between that port and Honolulu) was such as to warrant the installation of Babcock & Wilcox boilers in 1912 in the *Matsonia,* a vessel of 10,000 tons displacement.

In the *Matsonia,* however, it was considered advisable to install three Scotch boilers in addition to the six Babcock & Wilcox boilers, the idea being that the Scotch boilers would be better adapted for handling deck winches and other auxiliary machinery in port. It was found, however, as soon as the vessel went into commission (that is, when loading the first cargo), that the Babcock & Wilcox boilers were even better adapted for handling the deck winches than the Scotch boilers, and the latter were used only as spares, or to assist in developing maximum power in combination with the six Babcock & Wilcox boilers when in free route. It was a natural development, therefore, that Babcock & Wilcox boilers and superheaters should be used entirely in the new ship.

This is not the first time that Babcock & Wilcox boilers have been tried in combination with Scotch boilers on account of the prejudice existing in some quarters against watertube boilers in the merchant service. The coast guard cutter *Snohomish* was fitted with one Babcock & Wilcox boiler and one Scotch boiler, but experience showed on that vessel, as elsewhere, that the Babcock & Wilcox boiler was more economical in the expenditure of fuel, and that the cost of repairs and maintenance was materially less than for the Scotch boiler. Incidentally, also, in this vessel the power developed was greater with the Babcock & Wilcox boiler. Since the installation on the *Snohomish,* fifteen other coast guard cutters have been fitted with Babcock & Wilcox boilers to the entire exclusion of the Scotch type.

OBITUARY

Arthur E. Meyer, associated with D. B. Dearborn & Co., New York, died on December 4 in San Francisco, Cal., aged thirty-four.

Edward Smith, president of the American Shipbuilding Company, and of the Buffalo Dry Dock Company, died in Buffalo, N. Y., on December 5, aged seventy-one.

Henry R. Roper, chairman of the Leyland Steamship Line and a vice-president of the International Mercantile Marine Company, died recently in Liverpool, aged fifty-five.

Lucien Maxwell Brigham, a widely known machinery manufacturer and one of the directors of Manning, Maxwell & Moore, New York, died recently at his home in Orange, N. J., aged forty-two.

F. O. Smith, president and general manager of the F. O. Smith Shipbuilding & Dry Dock Company, Norfolk, Va., died at his home in Norfolk on November 19, aged fifty-three. Mr. Smith was president of the Board of Harbor Commissioners.

Leopold Katzenstein, head of the firm of L. Katzenstein & Co., and prominently identified with the marine engineering field for the past forty-five years as an inventor and manufacturer of steam engineering specialties, died on December 6 in New York, aged seventy-six.

James Mapes Dodge, president of the Link Belt Company, Philadelphia, Pa., died on December 4 at his home in Germantown, Pa., of pleurisy and pneumonia, aged sixty-three. Mr. Dodge was vice-president of the Franklin Institute, a former president of the American Society of Mechanical Engineers, and widely known as an engineer in the development of mechanical conveying machinery.

PERSONAL MENTION

Operating Engineers

J. M. Dougal has been appointed assistant engineer of the steamer *Reaper,* vice Everett Moats, resigned.

Melvin Leap, of Cincinnati, Ohio, has been appointed chief engineer of the river steamer *J. M. Ware,* vice M. Ellis, resigned.

Samuel Ellis, of Cincinnati, Ohio, has been appointed chief engineer of the river steamer *Hercules,* vice Arthur Doty, retired.

F. W. Ingram, a former marine engineer of Paducah, Ky., is associated with the Ingram-Tarleton Engineering Company, of Macon, Ga.

Hugh L. Edwards was appointed chief engineer of the steamer *Reaper* upon its recent arrival at Paducah, Ky., vice van Petty, resigned.

Monroe Fitzpatrick, of Cincinnati, Ohio, has been appointed chief engineer of the steamer *Lucinda,* with Richard Simms as first assistant.

William van Hoosen, chief engineer of the lumber district plant of the Great Lakes Dredge & Dock Company, Albany, N. Y., has resigned.

James Rhea, of Paducah, Ky., has been appointed chief engineer of the river steamer *Weenona,* with George Lendler as assistant engineer.

B. D. Bridenbaugh, of Paducah, Ky., has shipped as second engineer on the steamer *Golden Fleece,* of which W. D. Hardesty is chief engineer.

J. H. Reynolds, of Paducah, Ky., has been appointed chief engineer of the river steamer *Clyde.* A. L. Patmor is assistant engineer of this vessel.

George W. McNeese, of Paducah, Ky., has been appointed chief engineer of the steamer *Blue Spot,* with James G. Grimes as assistant engineer.

V. A. Hutchinson, of Paducah, Ky., has been appointed assistant engineer of the river steamer *North Star.* J. L. Weston is chief engineer of this vessel.

Robie Reynolds, of Paducah, Ky., for some time has had charge of the engines of the steamer *White Spot,* belonging to Captain William Berry, of Paducah.

John Pemberton, of Paducah, Ky., has assumed the duties of chief engineer of the steamer *Sidney* and will have the vessel ready for service on January 1.

Ambrose van Wie, formerly with the Great Lakes & Dock Company, Albany, N. Y., has been appointed chief engineer of the Barnett-Shoddy Company's plant at Albany, N. Y.

L. F. Taylor, formerly chief engineer of the river steamer *Lucinda,* has been appointed chief engineer of the plant of the American White Oak Leather Company, Cincinnati, Ohio.

William Washburn has been appointed chief engineer of the steamer William H. Kinch, of the Great Lakes Dredge & Dock Company, Albany, N. Y., vice Henry van Loan, resigned.

Peter Deitz, chief engineer of the harbor tug Robert N. Day, owned by the Davis Contracting Company, Albany, N. Y., was severely burned when the tug caught fire near Lagoon Island on December 10.

Captain John D. Silliman, one of the best known river men on the Hudson River, suffered a stroke of paralysis on the towboat *E. M. Levy,* at Castleton, N. Y., on December 5. Captain Silliman died on being brought to his home in Rensselaer, N. Y.

Henry Gates, formerly assistant engineer of the United States Government tug *General Totten,* has been appointed chief engineer of the United States Government tug *Colonel Thayer,* of the Albany-New York district, vice Samuel J. Ryan, resigned.

Changes in United States Steamboat Inspection Service

Howard N. Taft has been appointed assistant inspector of boilers, United States Steamboat Inspection Service, at Boston, Mass.

Martin Walle has been appointed assistant inspector of hulls, United States Steamboat Inspection Service, at Milwaukee, Wis.

Richard F. Bailey has been appointed local inspector of boilers, United States Steamboat Inspection Service, at Galveston, Texas.

William H. Gilman, formerly assistant inspector of boilers, United States Steamboat Inspection Service, at Boston, Mass., has been promoted to local inspector of boilers, succeeding Andrew Savage, resigned.

Gustav E. Atkinson, assistant inspector of hulls, United States Steamboat Inspection Service, at Milwaukee, Wis., has been promoted to local inspector of hulls at Chicago, vice Ira B. Mansfield, deceased.

Naval Architects, Consulting Engineers, Draftsmen, and Shipyard and Steamship Officials

Captain C. N. Dyson, U. S. N., was elected president of the American Society of Naval Engineers on December 30.

Dr. David S. Jacobus, advisory engineer of the Babcock & Wilcox Company, New York, has been elected president of the American Society of Mechanical Engineers.

Robert Bruce Steward has been appointed New York representative for the Marten-Freeman Davit Company, with offices in 17 Battery Place, New York, taking the place of the late C. J. Hale.

Louis L. Bernier, New York representative of the boiler department of the Kingsford Foundry & Machine Company, of Oswego, N. Y., has also been appointed marine agent of the Diamond Power Specialty Company, of Detroit, Mich.

Merton E. Farr, of Detroit, Mich., has been elected president of the American Shipbuilding Company, succeeding the late Edward Smith. O. J. Fish, formerly secretary and treasurer of the company, succeeds Mr. Farr as vice-president.

F. P. Palen, assistant to the president of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., was elected vice-president of the company on December 7. Mr. Palen's headquarters are at the New York office of the company.

Miller Reese Hutchinson, E. E., Ph. D., chief engineer to and personal representative of Mr. Thomas A. Edison, has been appointed by the Secretary of the Navy a member of the Naval Consulting Board and also as assistant to Mr. Edison, chairman of the Board.

Prof. C. H. Peabody, in charge of the Department of Naval Architecture and Marine Engineering at the Massachusetts Institute of Technology, Boston, Mass., has recently received notice from Baron Chinda, Japanese ambassador to Washington, that the Emperor of Japan has conferred upon him the Imperial Order of the Rising Sun, third class.

SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

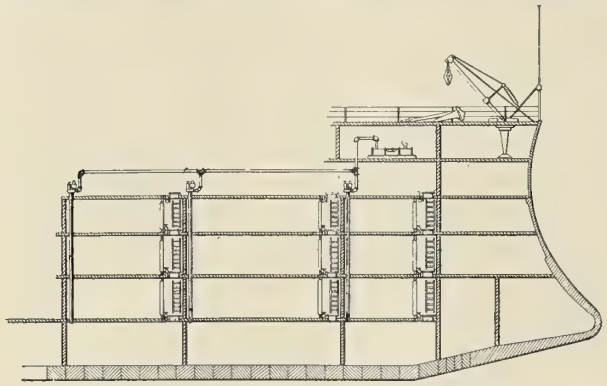
American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,150,799. METHOD OF INDICATING A SHIP'S APPROACH AND MEANS THEREFOR. EDWARD C. WOOD, OF SOMERVILLE, MASS., ASSIGNOR TO SUBMARINE SIGNAL COMPANY, OF WATERVILLE, MAINE, A CORPORATION OF MAINE.

Claim 1.—That method of submarine signaling which consists in disturbing a submerged electrically-generated magnetic field by the approach thereto of a body of magnetic metal whereby the electric current forming the source of said field will be disturbed, and causing the disturbance of said electric current to influence an indicating instrument. 3 claims.

1,149,709. AIR-PRESSURE SYSTEM AND METHOD OF OPERATION. WILLIAM WALLACE WOTHERSPOON, OF NEW YORK, N. Y.

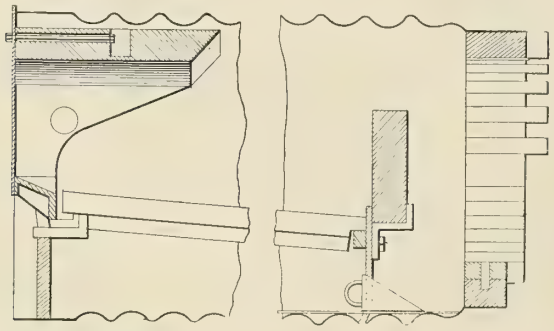
Claim 1.—The method of applying air pressure to ships' compartments to expel water from a leaking compartment and to reinforce said compartment against strains due to internal pressure, which method con-



sists in applying different degrees of air pressure internally to the leaking compartment and surrounding compartments respectively, said pressures being predeterminately selected so that the leaking compartment will receive sufficient pressure to expel water therefrom, and the other compartments will receive a relatively lower pressure to reinforce the walls of the leaking compartment against strains due to the higher pressure therein. 14 claims.

1,154,153. MARINE-FURNACE EQUIPMENT. ALFRED B. WILLOUGHBY, OF PHILADELPHIA, PENN.

Claim 1.—In a furnace, the combination with a front, a dead plate extending across the front, and supports mounted on the dead plate, a one-piece refractory arch having its terminals mounted on the supports and having its central portion extending inwardly from the supports and provided with a centrally lined recess disposed substantially midway



between the front and back edges of the arch, the arch further having an opening extending from the recess through the front; and a single supporting means for preventing inward movement of the arch comprising a straight bolt held in said opening and extending through the front, the head of said bolt bearing against the front, and a nut on the bolt within the recess and engageable with the front wall of the recess.

1,152,567. PROPELLING APPARATUS FOR VESSELS. LAWRENCE YORK SPEAR, OF GROTON, CONN., ASSIGNOR TO ELECTRIC BOAT COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim 1.—In a vessel, propelling apparatus comprising the combination of a propeller shaft, two internal combustion engines of different sizes, and means for mechanically connecting either of the two engines at will to the propeller shaft to drive the latter and thus propel the vessel whereby the vessel may be propelled at different speeds with the propeller engine operating at high efficiency. 5 claims.

1,129,934. PROPELLER. CARL THEODOR AUGUST HERMANN WIEDLING, OF NORTH BERGEN TOWNSHIP, HUDSON COUNTY, NEW JERSEY, ASSIGNOR TO THE WIEDLING MANUFACTURING COMPANY, OF NORTH BERGEN, N. J., A CORPORATION OF NEW JERSEY.

Claim 15.—In a rotary propeller, a hub and extending therefrom a plurality of blades of constant axial pitch both at the leading edge and the rear edge and so formed as to have driving faces of concave curvature in the co-axial cylindrical cross sectional lines thereof, the radii of curvature of which are multiples of the radial widths of the cross sectional water current areas pertaining to each blade section and the widths of the blades at the different radii of the propeller of which correspond to like multiples of the widths of the ideal blade of least width in which the radii of the cross sectional lines of the driving face are equal to the radial width of the cross sectional water current areas pertaining thereto and in which the axial pitch of both the leading edge and the edge of egress are the same as in the blades of multiple width. Fifteen claims.

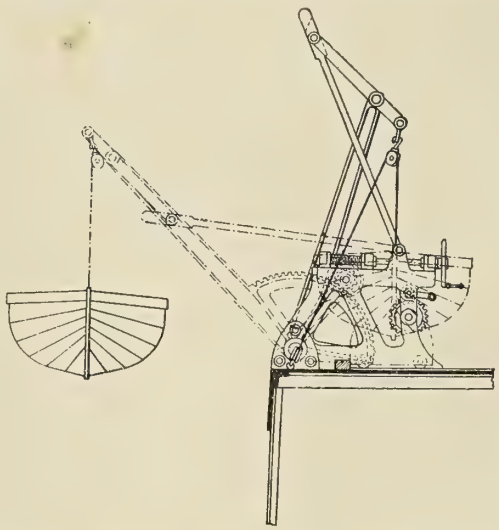
British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

5,085/1914. IMPROVEMENTS IN SHIPS' HATCHWAYS. H. MORGAN, 26 HARROWBY ROAD, SEAFORTH, LANCASTER.

Relates to the closing of ships' hatchways, companionways, ventilators, etc., from underneath in an air-tight manner so as to prevent escape of air and thereby prevent the entrance of water into the ship through openings which might be made by collision, stranding, etc. It consists in attaching underneath the deck near to the lower part of the coaming of the hatchway a surrounding plate or ring having a faced under-surface or provided with a resilient packing. Underneath this ring are two plates with faced upper surfaces corresponding to the ring; these plates are supported on guides or slides, so that they can be moved towards each other to cover the whole area of the hatchway and bed against the surrounding ring, thus closing and making the hatchway air-tight. The plates may be moved rapidly by rack and pinions or any other suitable means.

148/15. MEANS FOR LAUNCHING LIFEBOATS. J. DE BEER, OF SPEELMANSTRAAT, 135A, ROTTERDAM, HOLLAND.

According to the invention, two rocking davits are used, each having at its upper end a double armed lever, one arm of which is connected by a pivoted rod to the frame and the other arm of which carries the launching tackle of the boat. When the davits are rocked outwards the



said rods compel the double armed levers to rotate, so that the same first assist in lifting the boat off its chocks, and then by swinging out assist in holding the suspended boat clear of the ship's side. It may provide the said levers with projections which, when the boat has been swung out, abut against the davits, so that the rods referred to assist in supporting the load and thus reduce the stress on the davits.

2,486/1915. AN AUTOMATIC GAS BUOY. A. P. COLLIER, 15 WHITEHALL ROAD, HARROW, MIDDLESEX.

Claim.—According to my invention the buoy and gas generator are so constructed that a separate removable container or cartridge supplied with the gas generating material and closed to entry of the water can be placed in position in the buoy while the latter is afloat and open to the water, and can then be opened to the entry of water for generation of the gas. A flotation chamber carrying the aforesaid removable container or cartridge is surrounded by an annular chamber through which the external water can pass into the bottom of the buoy, where it rises until it reaches the gas generating material through a suitable adjustable valve and grid or perforated bottom belonging to the container, any excess pressure of gas driving the water back so that a condition of equilibrium is soon attained and the gas is generated as it is required.

27,806/1913. IMPROVEMENTS IN APPARATUS FOR COALING SHIPS. J. SCOTT, 3 KNOWSLEY ROAD, BOOTLE, LANCASTER.

This invention relates to apparatus for coaling ships and is especially applicable to large ships, such as Atlantic liners, in which a comparatively large quantity of coal has to be taken aboard, either in dock or harbor or from barges through numerous coaling ports; the object is to provide power-driven apparatus carried from one of the supper decks, by which coal can be transferred from the barges to each of the several coaling ports simultaneously by means of a series of tipping buckets adapted to be hoisted by means of hoisting drums carried on two fore-and-aft power-operated sectional line shafts, one arranged on each side of the ship, the gear being wholly or in part of a portable character. There is one hoisting drum for each coaling port and the buckets in their elevated position are adapted to discharge into the coaling ports either by tipping over or by the release of shutters or doors formed in the bottom of the bucket.